THE

TROPICAL AGRICULTURIST

VOL. LXIV. PERADENIYA, JUNE, 1925. **No. 6.**

BROWN BAST OF RUBBER.

For several years brown bast disease of rubber has received considerable attention and during some years it was so prevalent in some rubber-producing countries as to cause much alarm. It has been recorded from all rubber-growing countries but appears to be more prevalent in some than it is in others.

The early investigations of the disease were directed towards the finding of a causal organism, but these researches resulted in no definite discovery of any fungus or bacterium which could be held to be the cause of the disease. KEUCHENIUS, working in Sumatra, held that a bacterium was the cause of the trouble, but his views have not been supported by other workers and the concensus of opinion is that the affection should be considered a "physiological disease of non-organic origin."

In the present number of the *Tropical Agriculturist* are reproduced a number of papers relating to Brown Bast, as it is thought that they will be of particular interest to rubber planters in Ceylon. The reasons for concluding that the disease is a physiological one are summarized and the association between brown bast and heavy tapping discussed. Heavy tapping experiments in Java and Malaya demonstrated the connection between heavy tapping and brown bast.

It then became necessary to consider whether brown bast resulted from excessive withdrawal of latex, from wounding during the tapping operation or from other factors connected with the soil. A considerable amount of evidence collected at the beginning of the investigations seemed to indicate that wounding during the tapping operation was a factor of importance but additional evidence proved otherwise. Similarly in Ceylon, soil

conditions are held to influence the incidence of brown bast, but investigations so far made have not produced any conclusive results.

There appears to be every season to suppose that brown bast results from the excessive withdrawal of latex and MR. SHARPLES in his paper presented to the Imperial Botanical Conference last year goes further and considers that "brown bast is a disease of purely physiological origin depending mainly on the question of water relations in the plant tissues" He gives his views for such an opinion and one awaits the confirmation of the same from other workers.

In regard to control measures, Ceylon has always advocated the light scraping method. Several estates have adopted the method with success, and a number of experimental areas have been dealt with in recent years. The experience of estates in this matter is of value, as it appears that results are frequently variable. It has been found, for instance, that better results are secured if the work is done at certain times of the year, while if it is done at others the results are not so favourable. Practical factors enter into the question and cannot be overlooked.

Other countries report success from the isolation method of treatment and it certainly is worthy of serious consideration. It is stated that in Sumatra over 40,000 acres have been so treated with beneficial results.

Other questions raised relate to the liability of heavy yielders to brown bast and the effect that such considerations must have upon the future policy of the rubber industry towards bud grafting and seed selection. At the present time, there is no experimental evidence to show that high-yielding trees are more susceptible to brown bast than others, but the possibility must not be overlooked.

The question of seed selection and bud-grafting is certain to receive additional attention and any factors which are likely to demand consideration must be kept in view. Brown bast is not so frequently discussed now as it was a few years ago, but the losses produced by it annually in rubber estates are considerable.

RUBBER.

BROWN BAST DISEASE OF RUBBER TREES.

The following papers on "Brown Bast Disease of Rubber Trees" are taken from the Report of Proceedings of the Imperial Botanical Conference held in London, July 1924.

MR A. SHARPLES.

Brown Bast is the name given to a disease affecting the cortical tissues of the Para rubber tree. The common manifestation appears on the tapping cut, though it may make its appearance at places where large branches are broken by the wind or at the base of the stem where the bark has been eaten and injured by the gnawing of animals. On the tapping cut, the first undoubted symptom is the cessation of the latex flow from localised portions of the cortical tissues. These "dry" areas, on examination, are found to be discoloured, usually a brownish colour with variations towards a sepia colour, and when a substantial area of the cortex is suffering, the affected tissues are found to be water-logged. The affected tissues are not killed, but active secondary cambiums are formed in them ; as a result of the meristematic activity of these extra cortical cambiums, nodules or "burrs" appear on the tapping surfaces, rendering them uneven and incapable of being tapped.

OCCURRENCE OF BROWN BAST.

This affection, first definitely separated from other bark diseases of *Hevea brasiliensis* about 1917, has been recorded in all rubber-growing countries. During the years 1917-20 the disease became so prevalent as to cause much concern. During the last two years, since restricted tapping has been the rule, the affection has not caused planters much trouble, and as a practical methed of control, suitable for present-day practice, has been evolved, less attention has been paid to the disease.

BROWN BAST IN RELATION TO OTHER BARK DISEASES.

In 1914, this disease was lumped together with other bark diseases of *Hevea brasiliensis*, and all were supposed to be the result of the attacks of *Phytophthora faberi* (Maubl.). This position resulted from the investigations of Rutgers in Java, following on Petch's work in Ceylon ; the latter showed the connection between the fungus demonstrated by Rorer as causing cacao canker in Trinidad, and that causing a bark disease of *Hevea brasiliensis*.

Under four headings Rutgers included :

(*a*) Black stripe disease of the tapping cut.
(*b*) Claret coloured bark canker.
(*c*) Brown bast in the early stages.
(*d*) Burrs, the final development of brown bast.

(*a*) and (*b*) are now known to be caused by different species of the genus *Phytophthora*. while the credit for classing brown bast as a separate disease belongs to Pratt, who was working in Sumatra.

CAUSE OF BROWN BAST.

The early investigations into the cause of brown bast were directed towards searching for a causal organism, fungal or bacterial. These investigations resulted in no definite finding. Attempts to artificially transmit the disease from tree to tree were next made. Exhaustive efforts met with no success, so Belgrave suggested that the affection should be considered a "physiological disease of non-organic origin." This view obtained substantial support as further work was carried out, but Keuchenius, working in Sumatra, always strongly supported a bacterial cause. His own inoculation results do not lend much support to a bacterial cause, and the extra evidence he adduces is purely negative, being based on certain features which he claims cannot well be accounted for by a physiological theory. The writer is at variance on these special points, and is definitely of the opinion that most of these features can be better accounted for by a physiological theory than by assuming a bacterial origin. After three years' experimental work in the field, the view is advanced that the affection is a purely physiological disturbance resulting from the extraction of excessive quantities of latex.

TAPPING EXPERIMENTS RELATING TO BROWN BAST.

Rands, in Java, was the first investigator to establish experimentally the connection between brown bast and heavy tapping. His experiments were similar to those carried out in Malaya, and his results practically identical. The heavy tapping experiments he conducted were limited because of the short period of heavy experimental tapping, but were of importance in so far as they demonstrated a method for controlled experiment. The experiments conducted by the writer and Mr. J. Lambourne over the last four years have been based on Rands' methods, and much significant evidence has been obtained.

The only sound view to adopt when inoculation experiments designed to establish an organic cause prove a failure is that of a "physiological disease of non-organic origin." Coupled with this was Rands' successful demonstration of the association between heavy tapping and brown bast, which made the foundation for future work a fairly solid one, not only for obtaining evidence regarding the probable influence resulting in the inception of the disease, but for testing the possible effects likely to accrue from the efforts being made to establish permanent, high-yielding trees by propagative methods. During this period of restriction the latter is of far greater importance than the former, for future improvements on plantations appear to lie in a reduction of costs of production, while yields may be successfully maintained or increased by establishing stands of high-yielding trees, with a considerable reduction in the number of trees per acre. Thus if brown bast can be shown to be a reaction following on the extraction of excessive quantities of latex, it may be expected to prove a most important factor when future developments of trees giving high yields are to be considered.

POSSIBLE INFLUENCES OPERATING ON THE INCEPTION OF BROWN BAST.

Failing to establish an organic cause the investigation and correlation of factors influencing brown bast was of first importance. These influences were :—

(*a*) Excessive withdrawal of latex.

(*b*) Wounding during the tapping operation.

(*c*) Dry and rainy periods.

(*d*) Overcrowding.

(*e*) Soil conditions.

Up to 1920 there was little definite information upon which to base any conclusions, but it was generally held that the trees yielding most latex were the first to be attacked. As yields appreciably increase during a change from a dry to a rainy period, brown bast might be expected to be more prevalent during a rainy period. Badly developed trees grown under poor soil conditions appear relatively hardy; again the yield factor supplies the probable explanation, as yields from trees grown under unfavourable conditions are comparatively poor.

The significant investigation was the separation of (*a*) and (*b*) influences. This separation is difficult to negotiate in practice, but we have obtained a large amount of indirect evidence to indicate that the wounding influence is comparatively of small importance. In one of our experimental plots, where trials were conducted over an extended period, there was a decided correlation between increase in percentage number of brown bast cases and a sudden increase in yield. In the first two years there appeared to be some correlation between increase in percentage number of brown bast cases and rainfall, but in the third year the increase in percentage number of brown bast cases and yield took place during a dry period.

Special features noted in our experiments were:

(*a*) There appears to be a fairly definite correlation between yield and percentage development of brown bast, without any reference to other influences.

(*b*) A brown bast phase may be divided into a resting and developmental period, *i. e.* a sudden-rise period follows on a period when practically no brown bast cases are developed.

(*c*) The sudden-rise periods are so noteworthy that they can be validly classed under the heading of "trigger action" phenomena. A plot of trees under experiment would not show any increase in number of brown bast cases over a period of three to four months, then in a day or two a rise of from 10 to 50% would be recorded.

(*d*) The passage of brown bast developed on the tapping cut, downwards, is localised in a large percentage of cases when it arrives at a panel of bark of apparently greater age. Further, in a large percentage of cases, if the affection is noted in the very earliest stages, no progress is made if tapping is stopped. With reference to this last observation, it may be stated that this will not be likely to prove of importance in the control of brown bast on the plantations, for the careful and skilled supervision necessary cannot be expected when large areas are under the control of a single European.

Information has been gained respecting Rands' endeavours to develop immune trees by selecting good yielding trees specially resistant to brown bast as judged by heavy tapping. The writer was of the opinion that immediate conditions might influence this matter to a considerable degree, and that with a slight change of conditions in other directions the so-called resistant trees might prove liable to attack. In this connection, a comparatively good yielding tree, which had previously suffered from an attack of brown bast, but had recovered, remained free from the affection over a twelve months' heavy tapping period, while trees giving less latex and not having suffered from brown bast developed the affection. Further, we have shown that plots specially resistant at one period, later behave normally as regards the appearance of the disease. Such observations undermine the possibility of positive results being gained along the lines indicated.

Under controlled experiments, the results obtained lend colour to the view that the various features emphasised as a result of general observations under routine tapping conditions, cannot be trusted to any extent. To test the connection between good yielders and brown bast, towards which most observers have given support, two plots of twenty-five trees, one of good and one of bad yielders as judged by yields under routine tapping, were selected. These trees were then put under brown bast experimental conditions, *i. e.* one cut on a full spiral daily, and yield records taken for a month. At the end of this period, seventeen trees in the good yielding plot were definitely high yielders and sixteen of the bad yielders were definitely bad. Eight of the good yielding plot, and nine of the bad yielding plot formed a middle class which fell between the above two classes. The final results in the good and bad classes were quite definite; in point of time, over a seven months period, the good yielders showed a much larger number of brown bast cases than the poor yielders, but at the end of twelve months the poor yielding plot showed as many cases of brown bast as the good yielding plot. Susceptibility as applied to good yielders and immunity as applied to bad, are terms which cannot be used happily in the face of such results. The fact that poor yielding trees become affected with brown bast may be considered an argument against an exhaustion hypothesis, but in our experiments it was a common feature that trees about to become affected with brown bast showed either a sudden increase or decrease in yield. Extremely high yielding trees are the first to be attacked, while those that remain unaffected under extreme tapping show a steady yield. The truth appears to be that any tree subject to sudden increase or decrease in yield is liable to an early attack of brown bast, and poor yielders at any particular period may have been good yielders at some time in their previous history. It is extremely probable that the rhythm noticeable in most plant functions is a feature in the tapping *of Hevea brasiliensis* under extreme conditions.

The writer considers that brown bast is a disease of purely "physiological origin", depending mainly on the question of water relations in the plant tissues. Many investigators have suggested an "exhaustion hypothesis," with leanings towards the importance of the extraction of elaborated food materials. Now, if equivalent amounts of brown bast bark and healthy bark are ground up and extracted as thoroughly as possible with petrol, it will be found that there is no significant difference in the amount of extracted rubber; in

many cases more rubber can be extracted from brown bast bark than from healthy bark. Thus, as far as caoutchouc content, which is far and away the largest solid constituent of *Hevea* latex, is concerned, there seems no reason to assume that absence of elaborated food materials is of primary importance. The only other large constituent of latex is water, and the result of the disorganisation of water supplies to plant tissues is well known in plant pathology. The latex vessels are rich in osmotically active materials, and doubtless draw rapidly upon the supplies of water transmitted through the neighbouring cortical tissues. In the natural state the water relations between the varied parts of the cortical tissues are balanced, and under light tapping conditions this balance is not seriously affected, as the percentage content of solid and liquid in the extracted latex remains fairly constant. Under a system of heavy tapping the percentage caoutchouc content becomes considerably lower or remains low over long periods, with a resulting increase in percentage liquid content left after coagulation. Thus, under heavy tapping, extra water is extracted because of increased yields of latex, and the position is rendered more critical because the latex extracted contains more water in percentage volume than a similar amount extracted under lighter tapping operations. The greater strain involved in supplying such large extra demands for water must lead to a pathological condition in the transmitting tissues most immediately concerned, and as a result brown bast symptoms appear in the cortical tissues in the neighbourhood of the tapping cut.

The line taken throughout our investigations has been with reference to the disease factor influencing future policy in Malayan plantations. Much publicity recently has been given in the local press to the enthusiastic utterances of supporters of the policy of bud-grafting with a view to increasing the yielding power of the individual trees. The claim has been raised of a possible 1,500 lb. per acre from bud-grafted trees as against an average of 500 lb. per acre for Malayan estates planted in the ordinary way.

This pleasant picture has a reverse side which is not often turned to the light. Up-to-date, the rubber plantations of the Middle East have been fortunate with regard to disease, more especially as no serious leaf disease has yet been found. This indicates that the leaves of *Hevea brasiliensis* in Malaya are well adapted to resist attacks by parasitic organisms.

Our brown bast investigations show that excessive yielding will encourage pathological conditions. It is most certain that a tree of *Hevea brasiliensis* bred from a comparatively high yielder, but expected to be considerably better than the parent from the point of view of yield, will show physiological activities of a different order, and this change in physiological activity might result in important changes of leaf structure. Positive evidence to this effect has already been obtained in Malaya. On one estate bud-grafts were successfully established on three-year-old stocks. As is well recognised, root development is closely correlated with leaf development, and when the stock was topped the only draw on the nutrient supply from the roots was from the few dozen leaves of the bud-graft, which had to accept an excessive supply of nutriment. The result was a development of thin, flaccid leaves on the bud-grafts, which were being rapidly attacked and destroyed by several species of fungi, usually saprophytic.

Some change in physiological activities is a corollary of increased yields in bud-grafts, if the optimistic yields suggested materialise. A slight deficiency in development of leaf cuticle may bring momentous changes, as the parasitic alga, *Cephaleuros mycoidea* (Karsten), which is responsible for serious losses on tea, cloves and pepper, is commonly present as an epiphyte on rubber leaves, and it is only the strongly developed cuticle which prevents the entry of this organism into the tissues. The writer recently investigated the cause of the "black fruit" disease of pepper in Sarawak which has caused a decrease of revenue from $2,733,301 in 1903 to $712,122 in 1920, and found the cause to be this parasitic alga. Further, it is an established fact that rubber growing has been rendered unprofitable in British and Dutch Guiana owing to the attacks of a leaf fungus.

Apart from the brown bast factor, which is definitely connected with excessive yields, it would appear that the risks attendant upon developing high-yielding strains of *Hevea brasiliensis* are sufficiently great as to warrant excessive caution. It may be mentioned that the high-yielding "mother trees," from which the original bud-grafting experiments in Java started, have all developed brown bast since. Big claims have been advanced regarding increased yields as a result of these Javan experiments, but little attention has been directed towards the possibility of transmitting the disease factor, which might effectively put paid to any claims regarding increased yields.

One point remains to be mentioned as a result of Farmer and Horne's publications of the occurrence of degenerate "bast" elements in the phloem of *Hevea brasiliensis* affected by brown bast. As a result, brown bast is quite commonly regarded amongst European plant pathologists as a form of phloem necrosis, similar to that demonstrated by Quanjer in potatos. The writer has been in close contact with this phase of the brown bast problem since 1920 and can state with confidence that such a conception is entirely at variance with the facts. Lignification of the phloem elements, as demonstrated by the usual reactions for lignin, is a common feature in the renewed bark of healthy trees of *Hevea brasiliensis*, which could not be suspected of brown bast. These variations in the phloem elements seem to be quite casual and can have no connection with the disease.

FURTHER OBSERVATIONS ON PHLOEM NECROSIS (BROWN BAST DISEASE) IN *HEVEA BRASILIENSIS*.

DR. A. S. HORNE.

Since the publication of a preliminary paper on phloem necrosis in *Hevea brasiliensis* by the author (3) the work has received a certain amount of criticism which has emanated chiefly from workers and investigators who possess an intimate knowledge of the conditions under which the rubber tree is cultivated, and the diseases to which it is subject in tropical plantations, and whose opinions are for this reason entitled to consideration. It can be shown, however, that the criticisms are in the main founded upon misapprehensions as to the precise nature and significance of the special anatomical features briefly described in that paper for the first time.

It is believed that there are four counts in all which need to be dealt with by argument:

(*a*) As to whether the microscopical phenomena observed in the phloem of tissues affected with brown bast have been correctly interpreted.

(*b*) Do these phenomena bear a definite relation to the brown bast disease?

(*c*) Is the use of the name phloem necrosis for the disease justifiable?

(*d*) Are the deductions made by the author relevant?

(*a*) *Normal phloem.* The phloem of a fairly normally developed *Hevea* tree about six years old contains a number of concentric cylinders of laticiferous vessels separated from one another by tissue zones of varying width. These tissues are intersected by numerous medullary rays: the portions situated between the laticiferous vessels and medullary rays consisting of sieve tubes with their companion cells and phloem parenchyma. In the younger phloem the sieve tubes form the dominant feature, the parenchymatous cells are narrow and less prominent, but in the older phloem the position is reversed, the phloem parenchyma is prominently developed and the sieve tubes much less conspicuous. Scattered throughout the phloem occur lenticular pockets of stone-cells which vary in number and size according to the type of tree examined.

The sieve tubes in transverse sections show rather large outlines, and adjacent sieve tubes are separated by a partition wall usually directed more or less radially, which is in reality a section of a sieve plate. These sieve plates, which are long and almost vertical exhibit scalariform markings. On this account the sieve tubes exhibit a striking superficial resemblance to certain xylem elements. Upon treating with soluble blue, the areas of the plate between the sculpturing are stained, the coating of callus thus revealed in the youngest tubes being thin and appearing as a thin line on either side of the sieve plate when viewed in transverse section. Sieve tubes of this type extend to the third or fourth row of laticiferous vessels counting from the cambium. They are followed by a narrow belt of tubes which are strikingly conspicuous when stained with soluble blue, owing to the thickness of the callus. The companion cells associated with the sieve tubes are prominently developed. The sieve tubes immediately succeeding these in an outward direction are of a totally different character, the walls bulge inwards as if the tubes are plasmolysed and the sieve plates originally flat are curved, exhibiting in transverse section an outline resembling a more or less compressed letter S. The callus has practically disappeared. The companion cells associated with these tubes are with difficulty distinguishable. The phloem parenchyma is well developed and occupies the space yielded by the collapse of the sieve tubes and their companion cells. The appearance presented by the collapsed sieve tubes suggests that they are no longer functional, but it is difficult to ascertain from material preserved in formalin at what stage they cease to be living. The question of the period of functioning of the sieve tubes and their viability is of considerable importance in interpreting the microscopical appearance presented in tissues affected with brown bast. But these are matters which can be studied only in the tropics, since it is known that edaphic and climatic factors have a profound

influence on the anatomical structure of the rubber tree, and as in the case of the development of the laticiferous system, the functioning of sieve tubes will probably vary with the seasonal and other conditions prevalent in different parts of the world where this tree is cultivated.

Brown Bast. (1) Very early stages prior to the occurrence of external or microscopical burr formation.

A microscopical examination of a transverse section of the phloem of tissue affected with brown bast, as evident in authentic material of brown bast received at the Imperial College of Science and Technology, reveals a number of minute, yellowish areas. These often occur generally distributed throughout the phloem in the tissue regions between the intersecting rows of laticiferous vessels and medullary ray elements within a zone often limited on the cambium side by the third or fourth row of laticiferous vessels—in a tree of average type-counting from the cambium. The outlines of the smallest yellow patches—those nearest to the cambium—are suggestive of gum-filled intercellular spaces, but if the preparations are suitably stained it is found that the apparent cavities are intersected by sinuous wall outlines similar in appearance but not in staining reaction to the S-shaped sieve plates present in the collapsed sieve tubes of the normal phloem. When the phloem is viewed in longitudinal section, more or less vertical yellow streaks corresponding to the areas present in the transverse section may be observed ; these are clearly due to the presence of discoloured sieve tubes since the typical scalariform markings of the sieve plates can be easily distinguished. The sinuous outlines observed in transverse section are not restricted to the region, where collapsed sieve tubes are to be found in the normal phloem they may be observed nearer the cambium in younger and obviously plasmolysed tubes : tubes similarly situated in normal phloem would be considered functional. The narrow belt of sieve tubes with thick callus pads which forms such a characteristic feature of the normal phloem is not evident, or only a few sporadic elements of this type are present. Not only has the callus practically disappeared from the tubes in this region, but in addition callus is almost entirely absent from the tubes in the affected region of the phloem. In place of it there occurs a development of a substance which reacts strongly with ruthenium red, a useful reagent which was discovered by Mangin to possess a strong affinity for compounds of a pectic nature.

In 1921, Rands (8) working in Java, described a kind of gummosis of the intercellular spaces of the phloem of *Hevea brasiliensis*. The symptoms described, notably the occurrence of a yellowish substance in the supposed air spaces and the illustrations given in Rands' paper dealing with the subject, were strikingly similar to the appearances observed by the present writer in brown bast tissues. Since at the time of publishing his paper on phloem necrosis an element of doubt existed as to whether Rands was dealing with the same or a different problem, the question was left open and the present writer made it his principal object to show that similar gummy areas present in the phloem of trees affected with brown bast examined by him were not appearances due to gum-filled intercellular

spaces but, in reality, sections of yellow necrotic sieve tubes. At a later date, Rands, during a visit to this country, inspected the drawings made from the material in the possession of the Imperial College and agreed that the gummy areas were similar to those which had been under his observation in Java, and expressed the opinion that probably the writer's interpretation of the microscopical details was correct.

The gummy areas nearest to the cambium are composed of one or a pair of necrotic sieve tubes, but passing outwards, *i.e.* in the direction of the bark, they become larger owing to the fact that groups of cells including phloem parenchyma become involved in the tissue degeneration. In the region where the tissue necrosis is more advanced the laticiferous vessels are involved. The latex is yellow. Wound cambiums occur on either side of each row, often completely surrounding a number of elements in the row, and their activity has brought about displacement of the original tissues. The older cells derived from these wound cambiums become sclerotic with the result that plates of stone-cells occur in each zone of cambial activity.

(2) Early stages—microscopical burrs present but prior to the occurrence of external burrs.

Cambial activity has proceeded still further with the formation of new xylem and phloem elements : the latter include laticiferous vessels.

(3) Late stages. These have been dealt with in detail by Saunderson and Sutcliffe (10).

(*b*) The material in which phloem necrosis was first observed was obtained by Prof. J. B. Farmer from British North Borneo. It was collected from trees not definitely known to be affected with brown bast. The material showed no signs of even microscopical burrs. The microscopical features were thought to indicate very early stages of brown bast. In order to make sure Prof. Farmer obtained authentic material from Malaya and elsewhere. In every case phloem necrosis of a similar nature to that found in the original specimens was observed, and the conclusion was reached that the trees from which the Borneo material was collected were affected with incipient brown bast.

The recognition of the identity of the microscopical phenomena described by Rands and the present writer affords additional evidence of the association of the brown bast disease with necrotic phloem. Rands (9) states : "Brown bast is a non-parasitic disease of tapped trees characterised by discoloration and dryness of an area of bark extending below the tapping cut. The discoloration and cessation of latex flow are caused by the deposition of a yellowish gum-like substance in the tissues, impregnating many cell-membranes, filling the intercellular spaces and clogging the latex vessels.

(*c*) The name necrosis has been applied in the past to certain obscure diseases of plants characterised by the occurrence of necrotic tissue elements, and a special name has been employed when the necrosis is confined to particular elements. Thus the expression xylem necrosis has been applied to cases where degeneration of the xylem elements occurs (Kuster and other), and phloem necrosis in the case of degenerate phloem

(Quanjer). The name phloem necrosis was used to designate the leaf-roll disease of potatos by Quanjer in 1913 (5). That the diseases had not been proved to be of an infectious nature at that time may be gathered from the following quotations from a later paper (6) :—"This variety (Paul Kruger) under definite conditions of soil and climate must be so liable to the production of pathological bud variations that it is impossible to stop this process of degeneration. In his first paper on phloem necrosis, published in the winter 1912-1913, this stand-point had not yet been abandoned," and, "Forced to choose between these two explanations (which for the sake of brevity we shall call the mutation hypothesis and the infection hypothesis) we carried out systematically a series of experiments." The experiments were started in 1913.

Ståhel (12), working in Surinam, has recorded phloem necrosis in the Liberian Coffee plant.

The discovery of sieve tube necrosis in *Hevea Brasiliensis* places the brown bast disease in the category of obscure diseases in which the occurrence of phloem necrosis is a prominent feature, and the use of the expression does not necessarily imply the agency of a causal organism.

(*d*) With regard to the conclusions which have been drawn, these do not appear to be at variance, at least in any fundamental detail, with the opinions expressed by investigators of the problem in different tropical countries. Although the view has been taken in some quarters that the disease is due to bacterial organisms, the general consensus of opinion attributes it to physiological causes. In 1921, Prof. Farmer and the writer (2) directed attention to the prevalence of diseased sieve tubes in the young phloem and stated that a necrotic development of this kind, whatever the circumstances bringing it about, must interfere with the normal metabolic processes of the rubber tree. Whilst the possibility of the agency of parasitic organisms was borne in mind, it was clearly stated that such a condition might be due to some ill-defined physiological disturbance of the normal functions within the tree.

During the last few years a great deal of work has been done by Quanjer and others on leaf-curl and allied diseases of the potato.

Until 1913, these diseases were attributed to physiological causes. Quanjer, Van der Lek and Oortwyn Botjes have now shown that certain of the diseases of this group, notably leaf-roll, mosaic, crinkle, etc., are of an infectious nature. This conclusion is also reached by Murphy (4). The investigators working on this problem have never succeeded in finding any causal organism and agree with Quanjer, who expressed the opinion that such a variety of symptoms can only be explained on the hypothesis that there are a number of micro-organisms causing them. According to Quanjer, phloem necrosis (necrosis of the sieve strands) occurs only in the case of leaf-roll, and he finds a definite correlation between leaf-roll and phloem necrosis. This disease was found to be transmissible by aphides by Oortwyn Botjes in 1920 (1) and by Schultz and Folsom in 1921 (11). Some work in connection with the transmission of the leaf-roll virus has been done in this country by Whitehead (13). Taking into account the entirely different habits of the two plants, the parallel with *Hevea brasiliensis* is very striking. In

both, phloem necrosis is associated with a specific diseased condition of the plant; in both, sieve-tube necrosis is prevalent, and in neither case is any trace of parasitic organisms revealed by microscopical study. Nevertheless, it is not safe to assume from this parallelism that the brown bast disease is caused by a virus. A decision can be reached only as a result of investigations carried out in the tropics by competent specialists working with the definite object of settling the question.

LITERATURE CITED.

(1) Botjes, Oortwyn. *De bladrolziekte van de Aardappelplant.* Thesis accepted by the Landbouwhoogeschool, Wageningen, 1920.

(2) Farmer, J.B. and Horne, A.S. "On Brown Bast and its Immediate Cause." *India Rubber Journal*, p.25, June 18th, 1921.

(3) Horne, A.S. "Phloem necrosis (Brown Bast Disease) in *Hevea brasiliensis*". *Annals of Bot.* XXXV. July, 1921.

(4) Murphy, Paul A. "Some recent work on leaf-roll and mosaic." *Report of the International Potato Conference*, p.145, London, 1921

(5) Quanjer, H.M. "Die Nekrose des Phloems der Kartoffelpflanze, die Ursache der Blattrollkrankheit" *Mededeelingen van de Landbouwhoogeschool*, VI, p.41, Wageningen, 1913.

(6) Quanjer, van der Lek and Oortwyn Botjes. "Nature, mode of dissemination and Control of phloem necrosis (leaf-roll) and related Diseases (*i.e.* Sereh). "*Mededeelingen van de Landbouwhoogeschool*, X,p.1., Wageningen, 1916.

(7) Quanjer, H.M. "New Work in Leaf-curl and allied Diseases in Holland." *Report of the International Potato Conference*, p.127, London, 1921.

(8) Rands, R.D. "Brown Bast Disease of Plantation Rubber, Its Cause and Prevention." *Mededeelingen van het Instituut voor Plantenziekten*, No. 47, 1921.

(9) ..... "Histological Studies on the Brown Bast Disease of Plantation Rubber." *Mededeeling van het Instituut voor Plantenziekten*, No. 49.

(10) Saunderson, A.R. and Sutcliffe, H. "Brown Bast." *The Rubber Growers' Assoc.*, May, 1921.

(11) Schultz and Folsom. "Leaf-roll, net-necrosis and spindling-sprout of the Irish Potato." *Journ. of Agric. Res.* XIX. p.315, Washington, 1921.

(12) Stahel, G. "De zeefvatenziekte (phloem necrose) van de Liberiakoffie in Suriname (koffiewortelziekte)." *Meded. Dept. Landb. Suriname*, XII. 1917.

(13) Whitehead, I. "Transmission of Leaf-roll of Potatos" *Rep. of the Intern. Conf. of Phytopathology and Economic Entomology*, p. 147, Holland, 1923.

BROWN BAST—AN ENQUIRY INTO THE KEUCHENIUS TREATMENT.

The following article is taken from *Recent Developments in the Rubber Planting Industry with special reference to Budding, Brown Bast Treatment, Manuring of Rubber, Etc.*, by Herbert Ashplant, A.R.C.S., *Government Rubber Mycologist, South India.*

The mycologist of the Holland-America Plantations in Sumatra, Mr. Keuchenius, who has been working on the Brown Bast problem continuously since 1917, issued some time ago the results of his investigations. The original paper was written in German, and has appeared only in a German scientific journal. Owing to this, and to the fact that the one other account —a short summary—was published in Dutch, British rubber planters, with few exceptions, have remained in entire ignorance of work which may be regarded as the latest real contribution to our knowledge of Brown Bast.

Some of the results of the above-mentioned investigations appeared to me to be of such importance that I lost no time in bringing them to the notice of South Indian rubber planters. A few estates took up the new treatment straightway, and on others preparations were made for doing so. Disappointment with the results of past Brown Bast work had, however, made planters generally somewhat sceptical of the value of any measure against Brown Bast, and it was felt by certain planters who were keen enough to begin, that before committing themselves to further expense, it would be a good thing to get some first-hand information as to the effectiveness of the Keuchenius treatment. It was one of the objects of the writer's recent tour to obtain this fuller information.

Thanks to the courtesy of the H.A.P.M. Authorities, who gave me every facility, I was able to spend several days on their properties looking into the results of the Keuchenius Treatment. During my visit I was fortunate in meeting Mr. Keuchenius himself, and in being shown by him over the treated area. Mr. Keuchenius demonstrated the method of applying the Isolation Treatment under different conditions and cleared up certain difficulties Together with him, I inspected treated trees, new and old, and witnessed the Brown Bast gangs in operation.

As it is difficult to give my impressions of the results of the Isolation Treatment without reference to the details of treatment I have thought it advisable to repeat here the summary of Mr. Keuchenius's views of Brown Bast, and method of treatment previously circularised to South Indian planters. Comments on the treatment are made in the course of the description, and further comments follow at the end.

THE KEUCHENIUS THEORY OF BROWN BAST.

Dealing first with the nature and behaviour of the disease (which Kuechenius still holds is of bacterial origin) briefly, the investigations referred to show:—

(1) That Brown Bast is essentially an affection of the latex tubes, and is propagated from point to point in the tree solely along the latex tubes.

(2) In its original incidence, the affection is exceedingly local, and is limited to a very small area.

(3) The subsequent spread of Brown Bast, until it assumes the dimensions usually met with, is due to continued tapping on or in the vicinity of the diseased area. (This transference of the affection from diseased to healthy regions is termed by botanists "metastasis").

(4) The extension of the disease can be prevented entirely by the isolation of the affected zone by means of a deep channel to the cambium.

(5) Provided the isolation is efficiently carried out, tapping can be proceeded with anywhere outside the isolated zone, without any danger of the Brown Bast spreading thereto from the old patch.

That the continued tapping of a diseased tree would be likely to lead to the extension of the affected area is, of course, really implied in point (1), for if Brown Bast is a disease of the latex tubes, and is propagated solely along these tubes, it is easy to understand that tapping, by causing the movement of contaminated latex from diseased to healthy tubes, will, in all probability, set up the affection in these as well. It follows, also, from the same theory that the complete severance of all connections between the latex tubes in the Brown Bast affected zone, and those outside, would prevent the disease passing over.

There is, however, one difficulty which will arise in the minds of most people, and this difficulty I will now anticipate. Admitting, in the light of the theory expressed, the impossibility of the disease crossing the isolation gap, what, it may be asked, is going to happen when the gap has, in the course of time, been bridged by the development of new tissue? Once the connections are re-established, will not the danger of Brown Bast spreading be as great as before?

In answer to this question, it may be pointed out that contrary to popular belief, the latex tube connections, sundered by deep channels of this sort, are never re-established. Latex tubes are slowly regenerated in the new tissue behind the wound, but these are not continuous with the old ones on either side of the gap, and are quite unconnected therewith. The wound tissue, termed by botanists, "callus," which fills the gap, is distinguished entirely from the tissue cut away, and, as one would expect from theory and Keuchenius's observations, confirm, this "callus" forms just as effective a barrier to the passage of Brown Bast as an actual gap.

Keuchenius stated in his original paper, that out of the many thousand diseased trees so treated on the five thousand acres embraced in his experiments, not one case has been observed where the Brown Bast has spread from the isolated patch first affected, to the tissue outside. This statement is not wholly correct, for the writer, during his recent visit, found several instances in which the disease re-appeared outside the isolated zone. The number of cases in which this had happened was, however, infinitesimal, compared with the scores of thousands of trees on which isolation had effectively checked the spread of the Brown Bast, and when looked into, the apparent failures could nearly always be traced to imperfect isolation in the first instance.

Many of these failures find their explanation, it seems to me, in the procedure followed on the H.A.P.M. The control measures against Brown Bast on the H.A.P.M. are so contrived that the outbreaks of the disease

are spotted in the very earliest stages, and treated before they have involved large areas of cortex. Such stress is laid upon promptitude in treatment that at one time it was the custom to gauge the efficiency of the staff (both European and Native) by the proportion of large-area-infections recorded in the fields under their supervision. Where the supervision is good the majority of cases of Brown Bast are spotted and treated before they have spread beyond an area of a square inch or so. Should many cases be found in which the affection has extended, to say, three square inches in area, faulty supervision is suspected.

It is perhaps to be expected that on estates where the principle of keeping the affection to the smallest possible dimensions is constantly insisted upon, the Brown Bast coolies endeavour to make the isolation channel as near to the limits of the disease as possible. The result of this (since Brown Bast in its incipient stages is scarcely visible to the naked eye) is that, in a small percentage of cases the isolation is imperfect.

I draw attention to this feature of the procedure merely in explanation of the misses. I do not criticise it, because this policy of restricting Brown Bast damage to the narrowest possible limits, though risky, has much to be said for it under the conditions of the estates described. The policy insures that the minimum area of bark is wasted, and as the Brown Bast gang returns every 14 days, any imperfectly isolated examples can be dealt with in the following round before they have spread to a serious extent.

It is necessary to say that the policy of running things fine is only applicable under conditions akin to those on the H A.P.M., where the isolation gangs return frequently and regularly. The irregularity of the disease work on most estates and the lack of the efficient control possible on the H.A.P M, make it desirable to insist on the isolation channel being cut well to the outside of the disease. The first isolation should be the last one.

HOW TREES ARE RID OF BROWN BAST.

There are three conceivable ways in which a tree may be rid of Brown Bast :—

One is to strip the tree bare to the cambium, thus removing all unhealthy tissues. The stripping operation is drastic, but where it has been successfully performed, the new tissues which arise have been found to be free from disease. The defect of the stripping method is that it involves the entire destruction of all the laticiferous layers. As these are only replaced slowly the yields obtained from the renewals after stripping are exceedingly poor.

The second method is the familiar scraping treatment. Although, as originally carried out, this was a drastic operation, aiming also at nothing less than the complete removal of all diseased tissues, scraping seldom achieved its aim in practice, and such scraping as has been performed of late has consisted in the removal of the outer diseased layers only. The deeper layers are left for the tree to throw off—a process which has occasionally been assisted by the application of tar and such like medicaments.

The other conceivable method which is really no method at all, is where the tree is left to cure itself by the unaided agency of its own natural healing forces. Left alone, the tree naturally endeavours to throw off the affection. This it does by forming a layer of cork between the

healthy and diseased tissue. The formation of this cork layer leads to the drying up of the tissues external thereto, and they tend in the course of time to scale off.

Whether there is such a thing as "self-healing" in the case of a *Hevea* tree, affected by Brown Bast, has always been seriously doubted. Keuchenius, however, contends that trees do certainly cure themselves, provided "metastasis" is prevented by the isolation of the affected area, and provided also that tapping is limited to the unconnected zone without. Apart from the isolation operation referred to all that is necessary, in his opinion, is the excision of the burrs which occur occasionally as a secondary phase of the disease.

According to this view the curing process may be left to the tree itself. The repeated scaling off of the outer bark, initiated by the formation of wound cork, will, in time, rid the tree of most of the diseased latex tubes. A few will remain for years, but these gradually undergo necrosis, and after a short, though undefined period, become as so much dead harmless tissue. The position of these necrotic latex tubes quite near to the surface, and the fact that they are functionally unconnected with the newer series of latex tubes, prevents the further spread of the disease from the old degenerated layers to the healthy tubes within. The time taken for the complete necrosis of the Brown Bast tubes may be three, or it may be five or six years, but as soon as this has taken place, the tree may be regarded as cured, and tapping can be resumed with safety on the seat of the old affection.

DOES THE ISOLATION TREATMENT CURE THE AFFECTION?

Remembering the miraculously rapid cures, claimed by Harmsen and others, as a result of applying hot tar,. etc., many planters will be disposed to be sceptical of alleged Brown Bast cures. The more simple a cure professes to be, the more it is suspect. The fact that the treatment described is being practised daily on what are not only the largest, but the most scientifically-run estates in the world would,however, be a guarantee of soundness of the Isolation Treatment, even did not the theoretical case advanced for the treatment hang together.

Whether the cures claimed are beyond all doubt complete cures, only prolonged tapping on the treated zones will finally decide. Since treatment was not commenced until about five years ago, general tapping has not yet been resumed on the sites of the old disease on the treated trees. This much can be said, however, that wherever trial tappings have been carried out on zones, isolated, and believed to be cured, the yield of latex has been good, and the Brown Bast has shown no signs of reappearing.

Such a result, which has been repeated over and over again, is justification for thinking that trees on which Brown Bast is immobilized, so to speak, and prevented by means of an isolation channel from spreading to fresh fields, do throw off the disease in from four to six years. The disease seems to work itself out in the circumscribed patch. The appearance of the cortex, after this period supports this view, as also do the tappings which many estates are now carrying out on areas formerly scraped for Brown Bast, and rested for years. Cases have come within the writer's experience in which trees scraped for Brown Bast six years ago, and since rested, are to-day, yielding latex freely on the zones previously diseased.

These trees, if one may judge from their yield recovery, and the non-recurrence of Brown Bast must be regarded as cured.

WHAT DO WE MEAN BY A BROWN BAST CURE?

The statement just made raises the question as to exactly what one means by "cure." If asked the question, a few years ago, one would have replied that by a Brown Bast "cure," one meant the complete restoration of the healthy tint to the bark as well as yield recovery.

When the problem is looked at a little more rationally, it is clear that this is rather an impossible demand Once the tissue elements of a tree have been disorganized or converted into permanent structures (as happens, for instance, in Brown Bast cortex wherein the latex vessels degenerate, and many of the surrounding elements become dead stone cells), by no possible manner of means can a tree restore these altered tissues to their original condition. A tree can only recover by replacing all the altered elements by an entirely fresh set through the activity of its cambium. From this new tissue, and not from the rejuvenation of the old Brown Bast affected layers, the latex which we get when trees have "recovered from Brown Bast" is drawn.

With regard to the diseased elements, the tree has no blood to absorb them. They can only be got rid of by scaling. A tree, however, is unable to scale off useless layers in the rapid way animals throw off their old skins after cuticular affections. The scaling in trees is brought about by two factors—one physiological, and the other mechanical. Physiologically, a tree's chief reaction to wounds or disease stimulus is the production of cork. By the production of successive cork layers it continually endeavours to insulate its healthy cortex from the injurious influence of the overlying Brown Bast tissue. Since cork is impervious to water, and prevents the passage of food-stuffs, the effect of these corky barriers is to bring about the starvation of the external tissues.

The reaction described ends the direct physiological attempts of the tree to throw off the disease. The actual scaling off of the diseased layers is an indirect result of further growth. As the tree grows, by the addition of new tissues on either side of the cambium, the outer layers are compelled to spread themselves out over an ever-lengthening periphery. Being unable, owing to the presence of so many dead and inelastic elements, to expand in unison with the internal expansion, like healthy tissues, these layers have to give way.

In this way, through the production of cork, the Brown Bast layers are rendered innocuous; and gradually, under the tangential stresses created by the continued growth of the tree, become scaled off. Although the scaling process can be accelerated by bark scraping, which, as has been described, stimulates the production of a fresh cork cambium every time it is applied, the complete removal of tissues, which in bad cases of Brown Bast, may be half-an-inch in thickness, necessarily takes many years.

I have given this description of the healing process because, without some knowledge of what takes place, one's ideas of what constitutes a cure in the case of Brown Bast, must be rather cloudy. It will be evident from the foregoing, that, in demanding as a proof of cure, the complete removal of

every trace of diseases from the cortex, we have been demanding the impossible. For five, and possibly ten years (more where growth is slow) after the treatment, the bark will still contain discoloured elements.

The existence of mottled elements in the cortices of trees formerly affected with Brown Bast is then not to be interpreted as evidence of "non-cure." Keuchenius's definition of a cure from Brown Bast is the absence of metastasis. If, when the tree is again tapped, no further spread of Brown Bast occurs, the tree is held to be cured. His view, that the old Brown Bast layers become, after a number of years, necrotized, and incapable of setting up further infection, has already been fully explained. Experience of the isolation method on H. A. P. M., and the experience elsewhere of the scraping method, indicate the substantial truth of this view.

Since one must still expect to find in the outer cortex of a cured tree the residual traces of the old Brown Bast, the difficult practical point arises as to how one can tell when these discoloured elements have reached the harmless stage, and tapping can be resumed with safety. Though it is possible to get a fair idea of the stage reached towards recovery by inspecting the outer cortex, and noting whether it still retains the moist rotten apple appearance, which is the active condition, or has attained the dry brown mottled stage, indicative of innocence, the only real test of a cure is to tap the tree and see whether the disease spreads. The application of this test is more easily advised than carried out, and in practice, the best plan will, probably, be to fix a definite period like six years before recovery is assumed, and tapping recommended on the sites of former Brown Bast.

SUCCESS OF THE ISOLATION CHANNEL IN PREVENTING THE FURTHER SPREAD OF BROWN BAST.

So much for the curative aspects. With regard to the effect of the isolation channel in limiting the extension of the disease, the wide experience of the H. A. Plantations where the treatment has been applied over 20,000 acres or more amply confirm its value: The writer is satisfied from his recent visit and inspection of trees so treated, that the isolation channel, when properly made, entirely arrests the spread of Brown Bast. The great merit of the isolation method, apart from any question of cure, is that it permits of the continued tapping of the tree, whereas, with all other proposed remedies for Brown Bast, trees must be rested indefinitely.

DANGERS OF DOING NOTHING FOR BROWN BAST.

The foregoing general summary of the isolation treatment and its advantages will, it is hoped, be found useful by estates. For those planters who are still unconvinced of its value, or who prefer to do nothing, the following considerations are suggested:

Brown Bast has been proved to occur in much higher percentages on good than on poor soils. Appreciable additions to the number of affected trees are made regularly, even with alternate-day tapping. Brown Bast, indeed, seems to be an inseparable concomitant of tapping in any form we know of. It must, therefore, eventually involve a larger percentage of trees on the best than on the worst estates. Since the disease is propagated throughout the tree by the latex movements induced by tapping; a policy of *laissez faire* in regard to the trouble will only mean that the Brown Bast, which is increasing every year, will, by and by be spread all over the tapping

surfaces of the trees. The treatment proposed is so simple, and so inexpensive, that it would be foolish not to take advantage of the promise which it offers. The percentage of Brown Bast on the average rubber estate is high, higher, probably, than is generally supposed, and whenever the financial situation justifies it, I would seriously urge upon planters the desirability of taking up the systematic treatment of this trouble. Adverse climatic conditions have hitherto been a barrier to Brown Bast treatment during the greater part of the year, and the stripping method is totally impracticable in countries like South India, but climate, obviously, is no obstacle to the newer method above outlined.

More or less what the treatment involves will have been gathered from the foregoing, but for convenience the procedure is recapitulated below :—

PRACTICAL TIPS FOR THE TREATMENT OF BROWN BAST.

(1) With a scraping instrument, determine the outermost margins of the disease. In order to do this, it is necessary to scrape as deeply as is possible without wounding, for frequently, in Brown Bast trees, traces of the disease are met with quite near the cambium.

(2) Having determined, with very great care, the zone where Brown Bast tissue fades into healthy bark, make with a gouge knife, a deep channel around the diseased patch, almost to the cambium. This done, run a sharp knife—a penknife for preference—along the bottom of the channel, severing tissues right to cambium, and completely isolating the disease. A fine knife is used for finally severing tissues to cambium, since this avoids the bad wounding and bumpy renewal which occurs when the gouge tapping knife alone is employed for the purpose. This isolation channel should, for safety, be made a little outside the area actually found diseased. In fact, where there is any doubt about the exact limits of the disease, it is best to go two inches or more outside. *The importance of complete isolation must be emphasized, for if any diseased tissue is left outside the delimited zone the isolation cut is utterly useless.*

Where a lateral root is affected by Brown Bast, it will suffice to isolate it by making a circular cut on the tap root. Once the disease has been isolated, tapping can be proceeded with on a fresh surface outside.

Old cases in which the disease is confined to one half or one sector of the tree, but continues underground, present difficulties, since the removal of the soil from around the roots in order to make the isolation cut below takes time. The most practicable rule to follow here, is to isolate the diseased area completely (top, bottom and sides) only when this can be done without digging away of soil. Where the Brown Bast obviously extends far down into the tap root, the most economical solution is (after isolation of the tap region and sides of affected area above ground), to continue isolation channel right around the base of tree to other side, this isolating part below ground, and preventing disease being drawn up here. To avoid unduly depressing the yield from the healthy sector, the isolation channel made to keep disease from ascending to this region should be made as near to ground as possible. It should follow the outlines of the large laterals where they emerge from ground.

(3) In very old cases, where the disease is found to have extended almost completely around the tree, isolation can be accomplished by a

circular cut, *e.g.*, by ringing the tree above the affected zone. Tapping can afterwards be carried out with safety anywhere above the isolated area, but since the latex tubes have been cut through it will now be necessary to make the cut at least two feet above the isolation channel in order to get a good flow.

(4) Every few months, all treated trees should be inspected for traces of burring, any burrs discovered being removed straightway before they have got too large.

(5) Such portions of the treatment as are indispensable have been described in (1) to (4). Those who so desire, however, can assist the natural tendencies of the tree to self-healing, and bring about a more rapid cure by scraping away all the superficially attacked bark. Although scraping is not absolutely essential, it is always recommended since recovery will thereby be accelerated. The more of the outer diseased layers the tree can be encouraged to throw off, the better, and "scraping" induces bark scaling.

As to the kind of scraping desirable, deep scraping, aiming at complete elimination of all diseased layers, and which requires skilful, trustworthy coolies, is not called for. The rule followed should be to scrape down until slight bleeding shows healthy zone to be reached. Don't worry about the discoloured tissue still remaining. This will scale off in time. Scraping of the kind described can be done by any untrained coolies, and allows of the skilled men being kept wholly on the recognition and isolation work.

(6) Once the treatment of the accumulated arrears of Brown Bast has been accomplished, it will be easy to keep pace with the new infections. For bringing these to light quickly, before the disease has involved a patch larger than a square inch or so, a fortnightly inspection is recommended, or instead of this, tappers could be given some encouragement to report all suspected cases immediately.

COST OF BROWN BAST TREATMENT.

On the H.A.P.M. Estates, regular gangs are employed for Brown Bast detection and treatment. These follow the tappers in the mornings and mark the trees diseased, returning in the afternoons and carrying out the isolation work. The skill and speed acquired by coolies after they have been employed a short time at this work are surprising. A gang of ten men with maistry suffices to detect and check in its very earliest stages all the Brown Bast occurring on 1,600 acres. This will give some idea of the modest outlay necessary for controlling Brown Bast, when once the arrears have been attended to. An expenditure of one cooly per 160 acres is surely not much to pay for freedom from such a serious disease, particularly when this immediate treatment keeps every tree in the tapping round.

WILL THE SYSTEMATIC TREATMENT OF BROWN BAST INVOLVE LOSS OF CROP.

The fear has been expressed that the adoption by estates with much Brown Bast of the curative measures suggested will lead to a serious drop in output. Where the work is done unintelligently, of course, this will happen, but there is absolutely no reason why crops should fall to any extent if the new cuts are properly placed, since the great advantage of the isolation method of treatment is that it enables every tree to be kept in tapping.

It is difficult to lay down rules for the subsequent tapping of Brown Bast isolated trees, but the principle followed when placing new cuts, should be to place them at such a height as to give an extra area of tappable bark equal to that temporarily out of access through disease. Where, for instance, Brown Bast has involved the remaining twelve inches of tappable bark on one sector, and this has been isolated, the cut should be changed to the opposite sector at a height at least twelve inches above that at which tapping would normally start. Better perhaps open cut 15 inches higher since the 3 inches of bark above the isolation gap will have little yield value, and is best pared away when reached.

In cases where the whole base of a tree is affected, and has been isolated, a fresh tapping area should be projected above, and the cuts placed at such a height as to permit of eight years' tapping before coming on to the old Brown Bast affected zone.

One may leave out of consideration here trees freshly attacked by Brown Bast, and in which there is plenty of healthy bark below the isolation channel on the sector affected, for it should be clear that in such cases, tapping will be resumed below, after isolation.

From these examples, planters should have no difficulty in placing the new cuts on Brown Bast treated trees in any of the cases which are likely to arise. It may be mentioned that there is no objection to using the vertical isolation groove as the run-off channel for latex in cases where its position will serve that purpose.

If the new cuts are suitably placed on the lines suggested, the amount of crop loss through Brown Bast treatment should be negligible. The high cuts will, of course, yield less than the former low cuts when healthy, but they will in most cases yield as much, or more, than these cuts have done latterly, since becoming diseased. Then, too, must be remembered the fact that many trees which had gone completely dry on their normal cuts, are now, subsequent to isolation, and the opening of new cuts, contributing to the output once more (*Vide* Appendix).

APPENDIX.

Brown Bast.

Since the writer's visit to the H. A. P. M., a slight modification in the method of treating light cases of Brown Bast has been introduced. The modification has to do with the fresh cases met in routine inspection only, and not with the arrears of advanced cases which have to be dealt with first on all old estates.

The treatment prescribed for such early detected cases depends upon the position of the infection.

(*a*) When a small infected area is found at either end of the tapping cut, the isolation is effected as described earlier on, *e.g.*, first with gouge knife, and subsequently with penknife.

(*b*) All other small cases more towards middle of tapping cut, are isolated by means of a V shaped cut, the top of V being left open. In making these cuts, a pen-knife or sharp-pointed knife only should be used (not tapping knife).

The cuts must reach to the wood.

The object of this form of isolation (which is found to be satisfactory for the special cases described) is to permit of tapping being carried out over the entire length of the cut, just as on undiseased cuts.

It is important that the cooly employed in the routine detection and treatment of new cases should follow close behind the tapper, and inspect the cuts before the latex has ceased running.

It is desirable to say that the modifications introduced do not affect the mode of treatment for the outstanding arrears of Brown Bast, which should be dealt with in the manner already described.

As it is difficult to explain clearly, without diagrams, the procedure to be followed in all the special cases encountered in routine inspection for new infections, a separate circular setting forth this will be issued later on to South Indian Rubber Estates.

REPORT ON RUBBER TAPPING EXPERIMENTS AT THE EXPERIMENT STATION, PERADENIYA FOR 1924.

The old two versus three-day tapping trials on Plots 151-154.

The following table gives the yields per tree from the start in 1919 up to the end of 1924:—

	Two-day tapping.								Three-day tapping.								
	Yields per tree								Yields per tree								
	Series 1		Series 3		Series 5		Average		Series 2		Series 4		Series 6		Average		Percentage of two-day tapping yields.
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb	oz.	lb.	oz.	
1919	3	2	3	4	3	4	3	3	2	5	2	4	2	8	2	6	73·6%
1920	3	12	3	7	3	7	3	8	2	7	2	10	2	8	2	8	70·9%
1921	4	3	4	2	4	5	4	3	2	15	2	12	3	3	2	15	69·6%
1922	4	0	4	5	5	1	4	7	3	4	3	5	4	3	3	9	80·3%
1923	3	9	4	7	3	13	4	4	1	15	2	6	3	1	2	7	57·5%
1924	3	14	4	13	5	6	4	12	3	3	3	2	3	14	3	8	66·6%
Total	22	8	24	6	25	4	24	5	16	1	16	7	19	5	17	6	71·2%

Tapping was started in 1919 on 180 trees within narrow limits of girth dimensions. Since then 13 trees have been lost through *Fomes lignosus*, one casualty occurring in 1924. These losses have made the number of trees in tapping in each block very uneven and have somewhat vitiated the value of the figures. The first tapping cut was in all cases a single cut to the left at 30 inches from the ground at an angle of 22°.

The original bark allowance was 9·1 inches per annum for the alternate-day tapping, allowing a 6-year renewal, and 6 inches for the three-day tapping allowing a 9 years' renewal. When the experiment was planned the Bowman-

Northway No. 2 channelling knife was in use. The Michie-Golledge knife was adopted in 1920, and the bark allowance subsequently reduced to 8 and 5 inches per annum respectively. As the 6 and 9 year renewal programme has been adhered to, a good deal of untapped bark remains at the bottom of the trees in both methods of tapping.

As the cuts in both cases were started at the same height from the ground, the proportion of the alternate-day tapping yield obtained by the three-day tapping has fluctuated in accordance with the relative heights of the two cuts. Thus up to the end of 1921 the percentage gradually dropped, rising again in 1922 when the change-over to the top of the second panel was made on the trees under alternate-day tapping.

The change-over was made on the trees tapped every three days in July 1923. In 1924 therefore—the sixth year of the experiment—the alternate-day cut was on the lowest part of its second panel, while the three-day tapping cut (changed over in July 1923) was high up on its second panel. One would therefore expect the percentage this year to be the lowest recorded, and this is so with the exception of 1925 when a sudden and largely unexplained drop of yield in Serries 2 threw the figures out of proportion. In 1924 just two-thirds of the two-day tapping yield was obtained.

During 1924 the alternate-day trees received 176 tappings and the three-day trees 118 tappings.

A census of diseased trees taken in December 1924 revealed the following incidence:—

	Canker	Bark-rot	Brown Bast
	Percentage trees affected	Percentage trees affected	Percentage trees affected
Two-day tapping	12·3%	8·6%	3·7%
Three-day tapping	1·2%	4·7%	1·2%

In this case the incidence is in every case lower among the trees tapped every three days.

THE HILL TOP RUBBER

These simultaneous and overlapping experiments are here in progress:—

1. Comparison of three methods of planting.
2. Comparison of V cut with single cut.
3. New two- versus three-day tapping trials.

1. *Comparison of three methods of planting.*

Tapping was started on April 7th, 1922. The following table gives only yields of those trees in each block which are tapped by the same method: *i.e.* a single cut to the left at 24 inches from the ground at an angle of 16°; half the tapped trees in each block are thus tapped.

No. of block	Method of planting	No. of trees per acre	Yield per tree April 7th 1922 to Dec. 1923	Yield 1924. lb. oz.	Total to date lb. oz	Calculated yield per acre. 1924 lb.	Whole period lb.	Nature of land
A	Clumps of 4 trees 12 ft. by 12 ft. with 40 ft. between the clumps	69	6. 2	4. 14	11. 0	282	759	Sloping
B	Avenues Trees 15 ft. by 12 ft. with 40 ft. between the avenues	112	4. 0	2. 13	6. 13	315	763	Flat
C	20 ft. by 20 ft. on the square	109	4. 15	3. 9	8. 8	388	899	Steep and rocky.

The superiority of the yields per tree of the trees planted in widely spaced clumps is marked, but is not sufficient to balance the fewer number of trees per acre.

The average girths of all the trees in tapping are as follows :—

	December 1923.	December 1924.
Group A	33·33	36·64
Group B	34·12	36·44
Group C	32·69	34·98

Up to 1923 the growth as measured by girth appeared to conform to the nature of the land. Now the trees widely spaced in clumps have shown an increased girth and a higher average than those planted in avenues on flat land.

Disease incidence was as follows :—

	Canker	Bark rot	Brown Bast
Block A	7·3%	19·1%	Nil
Block B	3·8%	22·0%	1·7%
Block C	9·5%	20·5%	2·3%

These figures include all tapped trees : in Block A part are tapped with a V cut and part with a single cut, and Block C part are tapped on alternate days and part on every third day so that the figures are not of special significance.

2. *Comparison of V cut and single cut.*

Half the trees in Blocks A and B are tapped with a V cut and half with a single cut. Both cuts are at 16° at 24 inches from the ground on the half circumference. All the trees are tapped by the same man.

Period	Single cut Yields per tree			V cut Yields per tree		
	Block A lb. oz.	Block B lb. oz.	Average lb. oz.	Block A lb. oz.	Block B lb. oz.	Average lb. oz.
April 1922 to end of 1923.	6·2	4·0	5·1	6·5	4·8	5·6
1924	4·14	2·13	3·9	5·10	3·7	4·8
Total	11·0	6·13	8·14	11·15	7·15	9·15

The slight difference in yield in favour of the V cut has been increased in 1924 and now amounts to 1 lb. 1 oz. per tree for the whole period.

The disease census does not show any significant figures with regard to these two methods of tapping.

3. *New two- versus three-day tapping trials, Block C.*

In this experiment the cuts on the trees tapped every three days were started at 16 in. from the ground while the cuts on the trees tapped on alternate days were started at 24 in. from the ground.

Tapping was started on April 7th, 1922. A single cut to the left at 16° on the half circumference is used

The block is divided into six series, series 1, 3 and 5 being tapped on alternate days and the remainder every three days. Two tappers are employed, but their tasks are changed over monthly in order to equalise the personal factor. The trees tapped on alternate days received 174 tappings in 1924, and those tapped every three days 117 tappings. The average bark consumption figures were 7¾ inches and 5 inches respectively.

Period	Two-day tapping cut								Three-day tapping.								
	Series 1		Series 3		Series 5		Average		Series 2		Series 4		Series 6		Average		Percentage of two day tapping. yields.
	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	
April 1922 to end of 1923.	5	2	5	5	4	7	5	0	4	4	3	13	4	3	4	1	81·1%
1924.	3	6	4	1	3	5	3	9	2	12	2	13	2	15	2	13	79·0%
Total	8	8	9	6	7	12	8	8	7	0	6	10	7	2	6	13	80·1%

The percentages in the last column are generally larger than those obtained in the old two- and three-day tapping trials in plots 151-154.

The disease census shows no significant figures in the case of canker and Bark rot but in the trees tapped on alternate days 8 trees or 4·7 % are affected with Brown Bast while none of the trees tapped every three days are attacked.

THE HILL SIDE RUBBER.

Tapping on alternate days throughout the year vs. tapping daily on alternate months.

This block of 7½ acres is divided into six series, two of which are tapped on alternate days throughout the year, two daily in January, March, May, etc., and two daily in February, April, June, etc.

The method in all cases is a single cut to the left at 16° on the half circumference starting at 24" from the ground.

Tapping was started on April 7th, 1922, but the yields are given from May, giving four tapping months for each of the daily tapped series.

	Alternate day tapping						Daily tapping						Daily tapping						Average of 2 daily tapped blocks	
							Jan. March. May, etc.						Feb. April, etc.							
Period	Series 1		Series 6		Average		Series 2		Series 4		average		Series 3		Series 5		Average			
	lb.	oz.	lb.	oz.	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz	lb.	oz
May 1922 to end of 1923	5	6	4	14	5	2	4	13	5.	3	5	0	4	13	4	15	4	14	4	15
1924	4	1	3	11	3	14	3	9	3	8	5	8	3	13	3	14	3	13	3	11
Total	9	7	8	9	9	0	8	6	8	11	8	8	8	10	8	13	8	11	8	10

A superiority of 3 oz. per tree up to the end of 1923 in favour of the alternate day tapping has been maintained in 1924; and the gain is now 6 oz. per tree for the whole period of the experiment.

The incidence of disease is interesting in this experiment. At the end of 1923, including suspected cases 13 % of the daily tapped trees were affected with Brown Bast against 4 % of the trees tapped on alternate days. Some of the suspected trees have not developed further symptoms and in December 1924 11·8 % of the daily tapped trees were considered to be affected with Brown Bast and 7·0 % of the trees tapped on alternate days. The significance of the 1923 figures therefore has not been maintained.

The incidence of Bark rot on the other hand is 27·3 % in the trees tapped on alternate days and 12·1 % in the trees tapped daily for a month and then rested for a month.

Individual yields

Individual yields of dry rubber per tree have been kept in plots 14 and 15 since April, 1921, and in plots 11 to 13 since April, 1924.

T. H. HOLLAND
Manager,
Experiment Station,
Peradeniya.

THE USE OF MANURES IN THE GROWING OF *HEVEA BRASILIENSIS.*

The following is a report forwarded by Mr. H. C. Pinching, Assocciation's Senior Scientific Officer in Malaya to Rubber Growers' Association, London:—

The value of manures in the rubber growing industry is a matter upon which there is a considerable diversity of opinion in planting circles. Even in Ceylon, where on certain rubber estates the annual application of artificial chemical manures has always been the custom, there still exist planters in that country who question whether such a procedure is advisable. Reference to the Rubber Growers' Association "Bulletin" for July, 1920, will show that as a result of my visit to that island in February and March of that year I reported as follows:—"The general concensus of opinion among the planters of Ceylon is that the satisfactory returns per acre, which many estates are now giving, are greatly due to the use of manures. A few of the people interested in rubber are somewhat sceptical of the benefits of manuring rubber, as they say that up to the present *reliable* data as to the effects of manuring are difficult to obtain and, therefore, the matter is still open to question. Of course, there is a certain amount of prejudice among planters in favour of the use of manures on account of the experience with manures in tea cultivation."

In the writer's opinion it is natural that there should exist this diversity of opinions for the following reasons:—

(1) Very few comparative experiments have been carried out whereby reliable results have been obtained showing the true results (as measured in effect upon girth of trees and yields) of the manuring. General casual observations have been made and these observations may or may not have been influenced by prejudice or by preconceived ideas of what the results should be.

(2) The differences which occur in soils, when considered from the chemical, physical and biological stand-point, have received scant, if any, attention in discussing the results of such manuring work as has been carried out. Thus Mr. X has used basic slag for manurial purposes and from general observations he is certain that marked benefits have been received from that work. On the strength of Mr. X's success, Mr. Y tries basic slag as a manure and finds it resulted in no benefits to the trees, indeed, possibly the trees look poorer for the treatment. Mr. Y therefore makes a general statement that manuring is of no use for rubber growing. Mr. Y has overlooked the fact, however, that he has been treating a different kind of soil, a different lie of land, etc., to that treated by Mr. X.

Grantham, discussing the results of the manurial work on the properties of the H. A. P. M. in Sumatra is careful to point out in his summary (*Archief Voor de Rubber Cultuur*, August, 1914) that "Attention must be directed to the fact that the results described have been obtained on the special soil types peculiar to a part of the East Coast of Sumatra, and it by no means necessarily follows that similar results will be obtained on other soil types."

With reference to Malayan soils, either taken as a whole or even in special cases it is still unproven whether it would be a profit-bearing procedure to use chemical manures in the growing of *Hevea*. Green manures, since they serve a dual purpose, cannot be viewed quite in the same light as chemical manures. Analysis of the soil does not assist greatly in finding out what kind of chemical manure it is advisable to apply to rectify deficiencies in the soil from its rubber-growing fertility stand-point. The following statement from the Chief Secretary's Annual Report for 1920 of the F. M. S. is of considerable interest in connection with the question of the analysis of soils of Malayan rubber estates:—

"The conclusions arrived at by collating the results of soil analyses for rubber estates are recorded by the Director of Agriculture in the following terms:

"It appears from the results of chemical analyses, that much of the soil now carrying rubber is exceedingly poor, and is losing its virginal fertility with such rapidity that artificial compensating elements must shortly be resorted to on a large scale. In many cases, not only is the surface soil being denuded of its plant nutrients more quickly than weathering can replenish the supply, but the underlying subsoil is in an unhealthy condition, and likely to become more so on account of the water table and the character of the subsoil water.

"No definite data have been obtained to show the actual relationship between soil acidity and rubber yields, but the high order of acidity exhibited by the majority of estate soils shows that an unhealthy condition for root development is the rule rather than the exception.

"In connection with soil analyses for the estates, it must be recorded that there is a lamentable lack of interest displayed by the planting community in the whole subject of soil investigation, and there appears to be no desire to improve soil conditions by following up analyses with experimental work or fertilisation."

The only remark which one can make in comment of the above statement is that generally speaking the growth of the rubber trees in Malaya, their yields and general development have been of such a nature to satisfy up to the present, those who have invested their money in the rubber growing industry. At the same time, however, several hundreds of acres of land unsuitable for the growing of rubber (to judge from the results obtained) have been planted up and, further, no one will deny that the rigid clean weeding method of dealing with areas under *Hevea* which was carried out fot many years on the older estates has resulted in a great loss of fertility to the soil. In many cases the gradual retardation of the rate of growth of the trees planted on such areas has been very noticeable. To what extent this retardation is due to the gradual decrease in fertility or diminution of plant food in the soil is difficult to say, as in most cases of old areas two other factors, viz: Overtapping and overcrowding of the trees have also played a part. In the more recent years efforts have been made on estates to reduce the effects of these last two factors by tapping more lightly, by resting the trees from tapping for periods to allow a better bark renewal, by thinning out so that the improved spacing might cause an improvement in the branching of the trees which would stimulate growth and

improve the rate and nature of the renewal of the bark. Efforts have also been made to improve the soil conditions on many of these old areas by attempting to grow green manures and cover crops. Experience has shown that in many cases the establishment of cover crops or green manures on these old areas under rubber is very difficult, both the poverty of the soil and also the shade of the trees preventing satisfactory growth.

This naturally brings one to the question of the advisability of using chemical manures in the growing of rubber and this question seems to divide itself into the following sections:—

(1) The use of chemical manures to improve the fertility of impoverished soils which originally were fertile. The impoverishment can be produced either by "wash" and loss of plant nutrients by leaching or by the land having been planted with some other crop prior to the planting of rubber.

(2) The use of chemical manures on naturally unsuitable soils to render them suitable for rubber growing.

(3) The use of chemical manures on ordinary fertile soils to give an increased return.

(4) In all the above instances what manures should be applied? In connection with the first section I would suggest, that in view of our ignorance upon the matter, it would be highly advisable for estates possessing such areas under *Hevea* to carry out properly conducted manurial experiments with different chemical manures. Different soils may respond to different manures and until experiments have been carried out no practical manuring scheme should be entertained. That improvement in growth, in appearance and, what is most important, in yield, can be obtained by the use of chemical manures with rubber trees growing on impoverished soils has been clearly demonstrated by the careful experimental work, and the consequent field work carried out on the properties of the H. A. P. M. in Sumatra. A full account of this manurial work is given by Grantham in the *Archief Voor de Rubber Cultuur* for August, 1924. Accepting the possibility of producing an improvement in growth, vitality and yield of rubber trees by using chemical manures, the great question, with which one is confronted is whether this improvement, when measured in terms of increased latex yields or increased longevity (that is in terms of revenue bearing potentiality) is commensurable with the expenditure necessitated by the work. The late Mr. Kelway Bamber, in discussing the statements made in the Chief Secretary's Annual Report for 1920 with reference to Malayan soils (c. f. *The Planter*, Vol. II, No. 2, p. 50) stated :—

" . . . . . he was aware that very little manuring was done in the F.M.S. His experience was that the planting community there was rather averse to it, as manuring did not increase the yield of latex to any appreciable extent, and, therefore it was considered that it did not pay.

"Manuring was practised much more generally in Ceylon than in Malaya because it had been found that though it did not necessarily increase the yield, it kept the trees in a healthy condition. One of the chief results was the ensurance of healthy bark renewal. In a poor soil, where cultivation and *fertilisation* were neglected, the bark recovery was liable to be

poor. The effect of manuring was mainly on the tree itself. It was an excellent preventative of disease, as it kept trees strong and healthy.

"But," added Mr. Bamber, "manuring in the Malay States is absolutely out of the question from a financial point of view. There would be plenty of indications if this inability to manure was affecting the trees to any great extent. As I have said, the bark renewal would be poor, the leaves would be smaller and lose colour, and the whole appearance of the trees would show that they were not receiving sufficient nourishment. These possible ill-effects of non-manuring could, however, be prevented to a very great extent by proper cultivation, thinning out, and the prevention of wash."

With reference to manuring in Ceylon and maintaining the trees strong and healthy, Reeve, then Physiological Botanist to the Association in Ceylon, informed me when I paid the visit to the island, referred to above, that he considered that manuring had a marked beneficial effect in combating "secondary leaf fall" and "pod" diseases. It cannot be denied that repeated attacks by "secondary leaf fall" on the trees, have a marked detrimental effect upon the vitality of the trees, their yields and the rate of bark renewal. Hence if the application of manure to the soil can only cause the trees to withstand these attacks so that the trees can continue their normal rate of growth and yield, then the value of the manuring is a measurable quantity.

As has been already stated above, very little data is available expressing in a measurable quantity the value of using chemical manures for *Hevea* growing soils. Reference to my Report on my visit to Sumatra East Coast made in October and November, 1923, will show that I was informed by Mr. Grantham, that in some cases over 100 per cent. increase of yield was obtained as a result of the application of certain manures. Yields at the rate of between 500 600 lb. per acre were being harvested from the plots manured with sodium nitrate as against a yield of 280 lb. per acre from the unmanured plots. Further, no guide was necessary to inform a stranger which plots had received the sodium nitrate manures, for the effects of this manure upon the growth of the trees, their leaves and latex yield were remarkable. The growth of the trees on the unmanured control areas was poor, their branching scanty, and the comparatively few leaves they bore were of a sickly yellowish colour. On the other hand the trees on the manured plots had a much more vigorous growth, their leaves were plentiful and of a dark olive-green colour. According to Yates (*Archief Voor de Rubber Cultuur*, September, 1923), the rate of formation of latex vessel rings was accelerated by the application of various manures (sodium nitrate, calcium nitrate and ammonium sulphate) to the soils with which he was experimenting. It is essential to emphasize here that, according to Grantham, the use of basic slag, potassium chloride and lime was without effect on the two classes of soils experimented with, while superphosphate was actually harmful.

It was found on the H.A.P.M. that manuring with the sodium nitrate or ammonium sulphate every other year had nearly the same beneficial effect as a yearly application. About 5 lb. of manure was applied per tree around which it was merely broadcasted. Mr. Grantham informed me that the manurial work cost about Gls. 40 per acre, *i.e.* Gls. 20 per acre

per annum. Thus, assuming that the average increase of crop per acre when the work is carried out on a large scale is 200 lb., then the extra crop costs ten cents (guilder) per pound for manure or if the cost is taken over the total crop per acre it works out at about 4 guilder cents per lb. of rubber harvested. Where an estate output is unhampered by respective legislation then the work of manuring giving such beneficial results as obtained on the properties of the H.A.P.M. is certainly justifiable from the increased revenue stand-point. Where "restriction of output" legislation operates and where the ordinary cost of tapping per pound from unmanured fields is under four cents per pound, then viewed purely from a yield return stand-point, the manuring work would be hardly justifiable.

To Malayan estates the cost of manurial work with chemicals would exceed, in all probability, that stated above. The H.A.P.M. operates very large areas and purchases the manures in very large quantities. As far as I can gather the present prices of chemical nitrogenous manures are as follows :—

A local Kuala Lumpur firm quotes $ 210 per ton for sodium nitrate (16 % nitrogen) and $ 240 per ton for ammonium sulphate (20—21 % nitrogen). I have received another quotation of about $ 133 per ton c.i.f. Penang or Singapore for ammonium sulphate. The Singapore Gas Co.'s price for ammonium sulphate is, I understand $ 250 per ton f.o.r. The Chilean Nitrate Producers' Association quote the following selling prices for nitrate of soda for the year 1924-25. In July, 1924, the price will be £9 15*s.* 10*d.* per ton, delivered free at Chilean ports. The price will rise by small half monthly increments until January, 1925, when it will be £10 10*s.* 10*d.* per ton, at which figure it will remain until May 31st, 1925.

Thus applying about 5 lb. of manure per tree, *i.e.* approx. 4-cwt. per acre, the cost of the work, using locally procured chemicals, will be about $ 50 per acre per application.

According to the late Mr. Bamber the rubber tree does not demand a rich soil and the physical character of the soil is more important than its chemical character. In spite of this, however, I do not think it would be a commercial proposition to try to grow *Hevea* on naturally unsuitable soils (say, tin mine tailings) with the hope that the application of chemical manures will assist the growth. Neither do I consider it advisable where companies possess areas in which, by the failure of the present planting of *Hevea* to grow satisfactorily, the unsuitability and poverty of the soil has been clearly demonstrated, to uproot the present poorly grown trees, apply chemical manures to the soil and then replant the area.

Sufficient evidence is to hand to demonstrate the possibility of improving the growth and yields of trees growing on impoverished soil by the use of chemical manures and one is naturally led to enquire whether an advantage commensurable with the outlay would be obtained by using such manures in good soils, where the growth of the tree is satisfactory and the yields per acre over, say, 500 lb. per acre. Unfortunately no information is to hand as to the possibilities on this score. It is probable that the improvement might not be so great and further, by stimulating the growth of the tree to too great a degree, the possibility of rendering it more liable to attack by disease naturally arises. Still without a carefully planned experimental

enquiry nothing definite can be stated on this question. The possibility of rendering the soil toxic to the rubber tree by over manuring must not be lost sight of.

The question of what manures to use must necessarily depend upon the results of experimental work. Neither chemical nor mechanical analysis would render much assistance in settling this question. Chemical analysis indicates that many Malayan soils exhibit a high order of acidity and that they are poor in nitrogen. Most old estates have carried out a certain amount of liming of the soil in view of this natural acidity of the soil, but, writing generally, I have never seen any marked benefits resulting from such work. It might be added that usually the amount of lime applied per acre in these cases was not sufficient to neutralise the natural acidity of the soil. According to Barrowcliff (*Agricultural Bulletin*, F.M.S., November, 1914) the inland undulating land of the Peninsula has an acidity corresponding to 2-3 tons of lime per acre whilst the clays and peaty clays found near the West Coast would require 5-6½ tons to produce neutrality. Still it would appear that as some of the best rubber is to be found growing on distinctly acid soils, the question of acidity is not so important.

Having once found by experiment a chemical manure which is capable of stimulating the growth and yield of the rubber trees, either in the case of trees growing on impoverished or on good fertile soils, it is necessary, in my opinion to continue such manuring in these areas. Otherwise when the stock of extra supplied plant food is exhausted the trees will have to go back to their premanurial days supply of food. Hence they will not be able to maintain the same extent of leaf and branch as they required with the increased food supply. The trees will then show signs of dieback and be very susceptible to attacks by different fungi which may do considerable harm. Thus any company in deciding to carry out any manurial work must be prepared to continue such work. Without such a provision I would suggest that it is better to leave the trees to make the best of the natural supply of plant food existing in the soil, or to try some green manure, the effects of which will be more lasting.—The Malayan Tin and Rubber Journal, Vol. XIV. No. 7.

"BUBBLES" IN SHEET RUBBER.

In a paper published in a recent issue of the *Rubber Growers' Association Bulletin* (Vol. 6,10, p.625) Mr. H C. Pinching, A. R. C., Sc., Senior Scientific Officer in Malaya, ascribes the formation of "bubbles" in sheet mainly to fermentation of the latex caused by micro-organisms prior to coagulation. If, for various reasons, bubble formation is to be feared, sodium sulphite as an antiseptic should be employed, but otherwise there is no reason for the use of this anticoagulant. Is it quite certain that premature coagulation may not take place irrespective of "bubble" formation, and if so, is it generally accepted that the use of "held-sulphite" is limited to the prevention of the particular "fermentation" which causes bubbles.—Dr. Philip Schidrowitz, In the India-Rubber Journal, Vol. LXIX. No. 17.

COTTON

COTTON GROWING IN MADRAS.

C. A. BARBER, C.I.E., Sc.D.,

Lecturer in Tropical Agriculture in the University of Cambridge.

The Madras Presidency, covering over 90 million acres, extends, as far as cotton is concerned, from 8° to 16° north latitude, and is thus well within the tropics. Its boundaries are, however, irregular through the inclusion of the large native states of Mysore, Cochin, and Travancore; and in configuration it is broken up by two ranges of mountains passing generally north and south. On the west, close to the coast, is the continuous rampart of the Western Ghauts from 4,000 to close on 9,000 feet high; and on the east the Eastern Ghauts, close to the coast in the north, gradually recede from it till they are lost in isolated masses about halfway down. This configuration makes the Presidency one of the most delightful parts of India from the scenic point of view.

The indigenous cotton varieties are entirely rain-fed, and the annual fall in the cotton tracts roughly varies from 20 to 40 inches, this, considering the great heat of the tropical sun, is distinctly on the low side. As in all regions of periodic rains, the year is divided into "wet" and "dry" periods. The bulk of the rain falls between May and November, and it is not infrequent for the remainder of the year, December to April, to suffer from a spell of continuous drought for five consecutive months. The growing period for cotton is therefore somewhat strictly limited, and there are other factors which prevent the full rainy period from being completely utilized for this crop. In these conditions it is only possible to mature the crop because of the presence of a peculiar type of soil, specially fitted in all respects for the growth of the indigenous types. This is termed locally the "black cotton soil," and a brief description of it will be necessary in order to understand the Madras conditions.

This soil covers large areas between the mountain ranges, either in great plains or on slightly undulating land, and is intensely black in colour. It is not met with in Northern India, but covers immense areas slightly on the western side of the main axis of the peninsula. Its origin is rather mysterious, but the northern portion (Bombay, etc.) appears to have been derived from the trap formation, and the southern (Madras) from the prevailing gneiss. It is very uniform in texture, so as to show little difference between soil and subsoil, and remarkably retentive of moisture. It cracks deeply during the dry part of the year, but readily breaks down to a fine powdery mulch, especially under repeated shallow cultivation. The Madras black cotton soil is said to be rather poorer than that derived from the trap, is often slightly saline, and generally underlain by a layer of limestone concretions known as "kankar," which provides an excellent road material. The indigenous Indian cottons are distinctly deep rooting, and so possess a

considerable degree of drought resistance; they can thus, on this soil, go on growing and mature their bolls long after the last rains of the year have fallen. Lastly, the black cotton soil is markedly free from weeds of cultivation, and only a few kinds of trees are met with on it; so that the larger cotton areas present, during the off season, the appearance of boundless black desert plains, without the clumps of trees and scattered villages so characteristic of Southern India. Weeding costs are greatly reduced, a surface mulch is rendered easy, and we have here a fine example of dry farming, evolved by the cultivators in their ancient indigenous agricultural system.

Another factor of extreme importance which must be further discussed before we can form an opinion as to the Madras cotton conditions is the length of the growing period. In North India cotton is grown as a summer crop because of the winter cold; in the south of Madras it is a winter crop; and in the northern part of Madras a transition between these two extremes is met with. In the Madras Presidency cold is no longer a factor of importance; the incidence and duration of the rains dominate the position. The rainfall in the northern part, commencing in May, makes it possible to plant the crop during July and August, whereas in the extreme south it is necessary to wait till October. In both cases, because of the absence of rain after December, picking begins in February, and this leaves very little time in the south for cotton to grow. India is noted throughout the world for its short growing period for cotton, and this is shorter in the south of Madras than elsewhere in India with the exception of the extreme north-west. Nothing but the retentive nature of the black cotton soil, the drought-resistant character of the Indian species, and the intelligent labour of the ryot could enable the crop to survive.

On the average there are in Madras over 2,300,000 acres grown under cotton each year. There are five main tracts distinguishable, primarily dependent on the distribution of the black cotton soil, but also separated by the trade into time-honoured grades of lint. In the northern section, adjoining similar areas in Bombay and Hyderabad, a broad band extends from east to west and is divided into three tracts, termed Westerns, Northerns, and Coconadas respectively, diminishing in acreage, the first two together covering over 1,000,000 acres and the last under 250,000. The species of cotton grown are, in the Western tract, almost pure *Gossypium herbaceum*, with a rather short, harsh lint of a pure white colour; in the Northerns *G. herbaceum* with a considerable admixture of *G. indicum*, with a lint as a rule less white in colour but of distinctly superior length and softness; and in the Coconadas tract, which is less clearly defined in area, but has its focus near to the Northerns and extends in a north-eastern direction, an entirely new species is grown, named *G. obtusifolium*, with soft lint, often of a distinct khaki colour, irregular in length, and inferior in staple to Northerns. In the southern part of the Presidency there are two main tracts, known as Salems and Tinnevellies. The former is again less clearly defined, having its focus in the extreme west (Coimbatore) and extending in a south-easterly direction, while the latter forms a compact area in the extreme south of the Presidency. These two areas comprise 360,000 and 660,000 acres respectively; the predominating species is *G. herbaceum*, but towards

the south *G. indicum* comes in till, in the extreme south, it is the species almost exclusively grown. The lint varies with the species as in the northern region, but is, on the whole, of a better class. Included in the acreage of the southern tract, there is a newly introduced American species (*G. hirsutum*) grown under special conditions which will be referred to later.

Coupled with and dependent on the geographical distribution of these cotton in Madras, there are marked differences in elevation and climate. In the northern half we have the highest and driest cultivated land in the Presidency. In the heart of the Westerns tract, which has an elevation of from 2,000 to 3,000 feet above sea-level, less than 20 inches of rainfall on the average during the year, which means that in alternate years the total is less or more than this. Extreme dry heat is experienced during the early summer (April to June) while during the rest of the year the air is pleasantly cool. Much of the Coconadas tract lies little above sea-level, and the rainfall averages 40 inches; the weather, although often hot and steamy, has none of the great heat further west. The Northerns area, although broken up by ranges of hills, lies between the two in these respects, with a rainfall a little over 30 inches. Similar differences are met with in the southern region. The elevation is about 1,200 feet in the west of the Salems tract and sinks in a south-easterly direction to near sea-level, the rainfall increasing from about 22 to 30 inches or more. Most of the Tinnevellies tract is little above sea-level, and the rainfall is about 28 inches. The weather in the south is more insular in character, and, while there is a short cool season at Coimbatore, the rest of the tract is uniformly hot, but the heat of summer is less intense than further north.

Cotton cultivation in Madras is of a high order, but, as the cotton tracts are occupied by three different races, there are variations, sometimes of a substantial character. In all alike, as elsewhere in India, the "plough" is merely a heavy cultivator, and there is no attempt to turn the sod; indeed, such a thing as a sod is practically unknown. There is little difference between soil and subsoil, and this shallow cultivating action of the plough is not so primitive as would appear, when we consider that the conservation of moisture is the main aim in all field cultivation in this hot, dry country. In the Westerns and Northerns tracts and in the main portion of the Coconadas the cultivation of the Canarese and Telugus is often very good; and its chief distinction from that in the southern area is that the crops are drill-sown. The drill itself, a contraption of bamboos and ropes and bits of wood and iron, is, according to competent agriculturists, one of the most efficient and economical in the world; and the sowing in lines has given rise to a whole series of cultivators, harrows, and hoes, of very light draught, which can be run over a number of rows of the crop at the same time. Three-tyne implements are the rule, but they vary from one to twelve, all except the latter being easily drawn by a single pair of bullocks, and they are much simpler than the drill in structure, being made for a few shillings by the village carpenter and blacksmith.

In the south of Madras the Tamils are noted for their agricultural efficiency, and this is well seen in the cotton cultivation in the Tinnevellies

tract, although some very good work can be seen in the western focus of the Salems. But the drill is unknown to the Tamils, the seed being broadcast or dropped in the plough furrows; and this difference carries with it a world of others, the details of which cannot be even touched upon here. In place of the multitude of special implements in vogue in the northern region, the indigenous plough and hoe, with the right men behind them, are fully capable of dealing with all the needs of the crop.

The preparation of the ground is very carefully attended to, for the cultivators are well acquainted with the necessity of a perfect seed bed for germination and early growth. Cotton seedlings, because of their long tap root and large ear-like cotyledons, are specially liable to injury before the root branches, and foliage leaves appear. No manure is, however, given to the crop, because experience has taught the ryot that the rank growth thus induced during the warm, moist growing period would prevent the bolls from ripening before the hot, dry, early summer, when all immature flowers and bolls are quickly shed. Any manure that has been got together —cattle droppings, ashes, domestic rubbish, and crop residues—is given to the previous crop of the rotation; and this manure being of a slow-acting nature, while the rotation crop is a short one, much of it remains over unutilized.

Except in the case of poor farmers who, for financial reasons are, compelled to sow their cotton year after year, rotation is universally practised in Madras cotton cultivation; and the general selection of a cereal crop for this purpose is agriculturally sound. The cereal, besides being only for a short time in the ground, is shallow-rooted, and contrasts well with the deep-rooting cotton in its soil demands. The kind of cereal varies with the locality; but it is usually some form of millet, the staple rain-fed grain crop of the tropics of the old World; the great millet (*Sorghum*), Italian millet (*Setaria*), and spiked millet (*Pennisetum*) are the most important as regards rotation with cotton. Leguminous plants often enter the cotton fields, but this is more the case in the drill-sown tract; cotton is usually sown pure in the south.

Weeding, as already noted, is not a serious item, at any rate in the later stages of growth, but the land is continuously worked over after the rains have ceased, until the desired fine mulch of the black cotton soil is obtained, when the fields may be safely left for the maturing of the crop. Picking is not such a difficulty in India as elsewhere, and is usually done by gangs of women and children. It is, however, very badly done in the northern tracts, and, after close study, it has been found very difficult to see how this can be altered for the following reasons: In the Indian climate, where the sun becomes very hot soon after rising, it is most desirable that the cotton should be picked while the leaves and bracts are still pliable after the night's dew; for if this be neglected it is almost impossible for the pickers not to break off small bits when pulling the lint out of the bolls. According to the economic arrangements in the northern villages, picking falls to the lot of the women: these are quicker and better pickers than the men, and so have complete charge of the situation. As they have first to attend to the preparation and cooking of the day's food,

they are unable to enter the fields until the sun is well up, and the cotton suffers in consequence. The difficulty, moreover, appears to be a local one ; the pickers spend the day in the field and rely mainly on the evening meal, while in other parts the midday meal is the rule.

The marketing of the cotton leaves much to be desired, although improvements are being gradually introduced by the Agricultural Department in co-operation with the larger cultivators and merchants, and with the Indian Central Cotton Committee, which is devoting special attention to the prevention of the mixture of inferior cottons with good kinds that goes on so largely, and damages the reputation of the latter. The poorer cultivators—who constitute the bulk of the growers—always in need of money, are more or less in the hands of middlemen and money lenders, both functions being often performed by the same individual. Without external help, it is thus idle to expect the ryots to make any change in their time-honoured customs, although they may be very well aware that they do not receive the full value of their produce. The explanation of the anomaly is, however, fairly simple, in that mixing of inferior lint is a well-established practice in most parts of India, the idea being to do this so circumspectly that it will either not be noticed and the value of a superior kind obtained, or that the fine imposed will not be large enough to equal the gain obtained by this fraudulent practice. The introduction of co-operative selling, the establishment of regular buying markets, and the formation of buyers' associations, which would remedy these defects are not easy matters, because of the vested interests involved. And there is always the fact that the local middleman will go from door to door and pay cash down, knowing that the poor growers often cannot afford to wait, even if he be free to sell where he likes—which is not often the case. But improvements are gradually making headway, especially in those areas where new and better kinds of cotton have gained a definite status on the Liverpool market. In general, the local practice of judging the value of the cotton by its place of origin, using past experience for thus classifying it, makes it almost impossible for any improvement to be made in quality unless this is done on a large scale by co-operation.

A considerable amount of research work has been devoted to cotton in Madras since the formation of the Agricultural Department about twenty years ago : and in various directions marked success has been obtained in improving the character of the lint. The problem is, however, a different one in each tract, and a description of the way in which favourable results have been obtained would necessitate a much longer article than the present. Good work has been done in both the Westerns and Northerns tracts in selection among the indigenous varieties, but it is in the Tinnevellies that the most outstanding success has been obtained, after years of patient separation in the fields, mass selection, and selection along progeny lines ; and, when a good strain has been evolved, by introducing co-operative growing and selling among the larger cultivators and influencing the firms buying the cotton. The net result of this work, started in 1905, is that at the present time there is a grade of superior cotton sometimes known as "Tinnevelly American," but better known as "Pure Karunganni,"

which is well known and appreciated on the Liverpool market. The length of lint is $\frac{29}{40}$ to 1 inch, and the ginning percentage 25 to 26, as against $\frac{3}{4}$ to $\frac{7}{8}$ inch and 27 for ordinary Tinnevellies.

A further success has been obtained along an entirely different line—that of the introduction of a form of American Uplands, first grown in Tinnevelly, but reaching its greatest development in the western focus of the Salems, round Coimbatore. The Uplands type of cotton has not the deep-rooting system of the indigenous Indian species and does not, therefore, succeed in growing on the exiguous rainfall and in the black cotton soil; but, with occasional irrigation from wells, in land of lighter texture and colour devoted to the intensive growth of food grains and vegetables—land that is well manured and carefully cultivated—this cotton, called after its place of origin "Cambodia," has spread right over the southern part of Madras. The length of lint of this type is a little over 1 inch, and the ginning percentage 33, and it fetches a price equal to or slightly higher than ordinary Uplands cotton.—The Empire Cotton Growing Review, Vol. II. No. 2.

RECENT RESEARCH WORK ON COTTON.

An inspection was made by the cotton specialist (Mr. Wells) recently, of the Cotton Research Station at Melton, where the Department of Agriculture, in conjunction with the Empire Cotton Corporation and the Commonwealth Government, is conducting experiments to ascertain the cultural methods most suitable for the growing of Durango cotton in that area. A striking illustration of the effect on the growth of a cotton plant, that thinning has at different stages of the plant's development, was shown in an experiment in which small blocks of the plants were thinned when they were 4, 6, 8, 10, 12 and 15 inches in height respectively. The plants in the blocks which were thinned when the plants were 4 inches to 6 inches in height were of a blocky, thick-stalked nature—well laden with squares which were soon to commence flowering, while the plants which were thinned when 12 inches and 15 inches high were of a slender, spindly stalked type, with just a few squares developing in the top of the plant.

Another experiment of decided interest was that demonstrating the value of cross-harrowing in the early stages of the development of the plant. Material advantage had been obtained by cross-harrowing with a spike-toothed harrow, in that the amount of cultivating with a machine and hand clipping had been greatly reduced in the period before the plants were thinned, and if the season had been less favourable it is believed that the extra mulching in the row around the plants would have been shown to be of decided assistance in conserving the moisture. Close examination of the plants failed to show any signs of injury having been done to the plants, even where harrowed once a week, and from the results obtained in the experiment and also from the experiences of growers in other districts it appears that where the grower has a good strike he may do very efficient work with the spike-tooth harrow up to time of thinning when the plants are 4 to 6 inches in height.—Queensland Agricultural Journal, Vol. XXIII. Part 1.

SOILS AND MANURES.

SOIL EROSION EXPERIMENTS ON EXPERIMENT STATION, PERADENIYA.

T. H. HOLLAND M.S.E.A.C.,

Manager, Experiment Station, Peradeniya.

There are two areas in which the slope appears sufficiently uniform for practicable purposes, and each area could be divided into a maximum of 6 plots 15 ft. × 96 ft.—1/30th acre.

Six methods of treatment could thus be duplicated. In addition to the above plots one or more extra plots on rocky ground could be provided.

It is assured that this question is mainly of interest with regard to tea land. The two areas chosen were planted in tea in June 1919 but owing to poor soil and adverse conditions a great deal of supplying has been required, and there are a number of young supplies among the older bushes. Both areas are at present shaded with Gliricidia maculata 16 ft. by 16 ft. and possess the normal contour drains.

The following possible methods of treatment suggest themselves, and, if this ground is used, and the treatments are duplicated, not more than six must be selected for adoption.

1. Bare land, no tea, no drains, clean weeding.
2. ,, ,, ,, ,, clean weeding, ordinary contour drains.
3. Tea, clean weeding, no shade trees, no drains.
4. Tea, clean weeding, no shade, ordinary contour drains.
5. Tea, no drains, shade trees, no weeding.
6. Tea, no drains, shade trees, selective weeding.
7. Tea, clean weeding, drains, shade trees.
8. Tea, clean weeding, drains, no shade.
9. Tea, clean weeding, shade, stone terraces, drains.
10. Tea, clean weeding, shade, stone terraces, no drains.
11. Tea, continuous cover of Indigofera endecaphylla.
12. Tea, contour belts of Indigofera endecaphylla.
13. Tea, continuous cover of Centrosema pubescens or Vigna oligosperma.
14. Tea, with contour belts of Centrosema pubescens or Vigna oligosperma.
15. Tea, with contour hedges of Clitoria cajanifolia.
16. Tea, with contour hedges of Tephrosia candida.
17. Tea, in contour hedges, no cover crops, no drains, clean weeding.

Nos. 11 to 16 no drains, weeding between cover plants; all shade or all no shade as desired.

It is proposed to build cemented pits of a size to be determined by previous experiment with earth pits, to catch the wash at the bottom of each

plot. Whether individual pits higher up the slope should be added is a point that needs discussion.

The pits must be fully large enough to take all water and silt which comes down the slope and roofed in to prevent direct entrance of water. They must be impervious, but provided with a drain plug; absolutely level and of uniform cross section.

The suggested method of measurement of results is to (1) measure the height of the puddled water and silt in the pits, (2) take an average sample of this material and determine the dry weight of a measured quantity in the Laboratory. Experience must be gained with this method before the experiment is commenced. In addition separate yields of the plots under tea would be recorded.

It is proposed to isolate each plot with a serviceable bank or low wall.

Drains are certainly a difficulty. In the plots which are to have drains, the drains would have to be led across the plot at a normal gradient and then straight down the side of the plot into the pit. This would not be representative of normal draining, and it is a question whether drains would not be better left out altogether. One of the areas is very steep and is composed of poor soil; the establishment of cover crops here would be a difficult and slow proceeding. It will be a good many months before all the desired conditions could be established, whichever treatments are chosen, but experience in methods of recording etc., could be gained in the meantime.

PREVENTION OF SOIL EROSION UP-COUNTRY.

HUNTLEY WILKINSON.

Having been furnished with seed of 9 varieties of leguminous plants in order to test their growth up-country by the Superintendent of the Experiment Station, Peredaniya, some six months ago, I am now in a position to make a short report upon them, showing their growth on Talankande Estate at 4,600 ft. Mr. Holland sent me 9 Cigarette tins full of seed of the following varieties which I carefully put out along the top sides of 8 different drains and 1 road in a 26 acre Field of tea, as follows :—

Drain No.	1.	Crotalaria Incana
,,	2.	Tephrosia candida.
Road		Leucaena glauca
Drain No.	3.	Crotalaria Striata.
,,	4.	Clitoria cajanifolia
,,	5.	Sesbania aculeata
,,	6.	Indigofera arrecta
,,	7.	Crotalaria muijussi (Crotalaria usaramoensis).
,,	8.	Cassia Hirsuta.

The only three which have shown any kind of establishment worth mention are in order of merit:—

Crotalaria muijussi.
,, striata,
Clitoria cajanifolia.

Of these, the growth of the former is far and away better than that of the other two. the height now averages about 4 ft. I am now pruning some of this at 6 in. from the ground to see how it will stand this treatment at my elevation.

I also received from Peradeniya about the same time 12 cuttings of Napier grass cut from about a 12 foot growth.

Half of these I planted in an exposed place in the teeth of the South West Winds and half in a less exposed place. The average height of the former is 6½ ft. and of the latter only 4½ ft. I intend to establish this also on the top sides of drains and to keep it cropped in the way in which Paspalum is treated in this District.

I have also established Paspalum above my roads and drains throughout a steep 25 acre field in order to watch its efficiency as a wash preventative and to see whether the tea in its vicinity will suffer at all from sourness of soil.

When this estate was originally planted in Tea, Tea hedges were established above certain of the roads—the nursery plants with twisted roots being probably used for this purpose.

The efficiency of these hedges as soil "holders" is most marked and this method has the advantage over other methods in that these said hedges are plucked from in the usual plucking rounds.

On Middleton estate some 500 ft. lower in elevation, Guinea grass was planted on the top side of the watercourse at least 20 years ago to my certain knowledge—evidently for the purpose of holding up soil. Where this is still existent the soil collection is very marked and the tea in the vicinity does not appear to have suffered.

To my mind the order of merit of wash preservative methods is as follows:—

Easily first.	...	...	Tea hedges.
Second.	...	...	Grass establishment
Third	...	...	Stone terracing
Fourth.	...	...	A nitrogenous plant which thrives at the elevation required.

The objections to stone terracing are that there is no end to this work because, as the soil rises the top of the wall has to be continually added to Grasses on the other hand rise with the soil as it collects.

The objections to these leguminous plants appear to be that they are not in any sense *perennial*, and when they die off the bank of earth which has been formed breaks down again.

It is hard to see why such a point is made in Ceylon that after a field is pruned, the earth collected on the top side of the bushes should be carefully removed. Surely the collection of this earth in steep fields at any rate, is what is required?

Too diligent a removal of "root suckers" too on steep land is perhaps being resorted to? The benefit of their establishment surely outweighs the other evils?

Oxalis.—There is a very steep 25 acre Tea field on Talankande Estate (which the late Mr. Bamber inspected about 3 years ago) where Oxalis corrimbosa is prolific and has been so to my knowledge for at least 20 years. During the last 8 years I have encouraged its growth, hand weeding through it only and only clean weeding it at times when drought kills all its foliage, which happens perhaps only once a year.

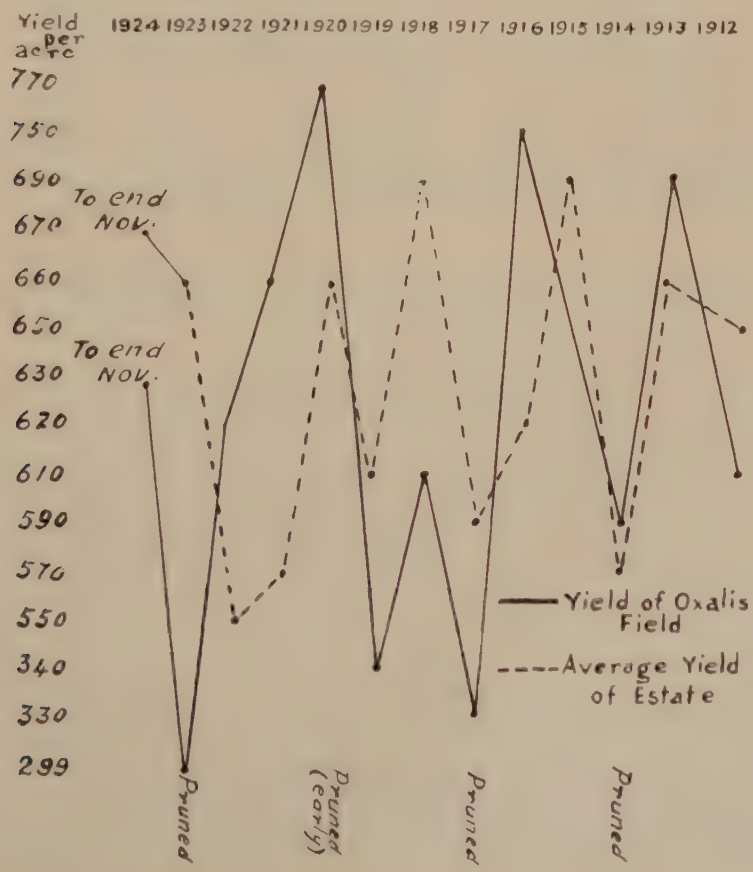
Here is a Graph showing clearly the yield of this field as opposed to the Average Yield of the whole estate since 1912. The pruning programme has been a three yearly one and it has not received any special manurial treatment whatever.

On the average I think it will be agreed that it has held its own well.

The Oxalis is responsible for the abundance of soil on this steep field which, had there been no cover plant at all, is bound to have suffered to a very considerable extent from soil erosion.

I have not as yet had any experience of planting out leguminous cover plants in this district but understand that Indigofera endecaphylla grows well.

I am trying a dadap hedge above some drains now—it, being a perennial, might be the very thing we are looking for.



PESTS AND DISEASES.

THE TEA TORTRIX PEST.

Report of Sub-committee appointed by the Maskeliya P. A. to enquire into methods of dealing with the Tortrix Pest.

It is agreed that to eradicate a pest it is essential to attack the source of supply. In the case of the Tortrix all known means of ensnaring it in the moth stage by traps of dry leaves, etc., having proved impracticable, it remains to attack it when immobile.

We therefore make the following recommendations to be tried over a period of three years by all Estates in the District :—

1. The collection of egg masses.
2. The taking of all flush attacked by caterpillars as soon as possible.
3. Intensive cultivation generally which tends to alleviate the after effects of attacks.
4. High shade. This can best be obtained by growing Albizzias and Dadaps, and in lopping the latter, care should be taken only to cut alternate lines.
5. Encouragement of bird life, by planting trees such as wax trees and Madras thorn for roosting and breeding, cover in ravines, keeping them distributed as evenly as possible over the whole area.

It must be understood that to make these recommendations productive of good results it is essential that all estates should comply with them; in fact it is almost safe to say that those who do not will soon find themselves the host of the pest which has passed their neighbours by.

C. B. PRETTIJOHN.
Chairman.

R. MURDOCH.
Hony. Secy.

HOUSE FLIES.

Extract from Report of Government Entomologist for 1st quarter 1925.

"As the results of complaints from some estates that flies breed in manure before its arrival at the estates, the Assistant Entomologist, at the request of one of the Colombo firms interested in the sale of artificial manure undertook the investigation of this problem. This investigation has occupied most of the first quarter and has included extensive breeding experiments of house-flies on an estate, in manure works and in the Laboratory. A full report on the subject will be issued later. Meanwhile the Assistant Entomologist is of opinion that house-flies do not breed in the manure under the conditions in which it is mixed, bagged and despatched from the works of the firm in question nor, under usual conditions, while in transit to estates, but that flies do breed in certain mixtures immediately following their application in the field giving rise to a new generation of adult flies in the course of about 12 to 15 days under suitable weather conditions. Succeeding generations may follow at intervals as long as sufficient manure remains in the soil in a condition in which it will provide food for the developing larvae."

TRADE MARK 'TABLOID' BRAND

Quinine Products

Some outstanding advantages:

(1) Exceptional purity and keeping quality

(2) Ready solubility and rapid action

(3) Compactness, portability and convenience in administration

'Tabloid' Quinine Bihydrochloride and 'Tabloid' Quinine Bisulphate, in bottles of 25 and 100, Plain or Sugar-coated, at all Chemists and Stores

BURROUGHS WELLCOME & CO.
LONDON

Reduced facsimile

xx 4212

All Rights Reserved

CEYLON AGRICULTURE.

ESTATES PRODUCTS COMMITTEE.

Minutes of the Twenty-fourth meeting of the Estates Products Committee of the Board of Agriculture held at the School of Tropical Agriculture, Peradeniya, at 9 a.m. on Saturday, May 9, 1925.

Present:—The Director of Agriculture (Chairman), The Government Mycologist, The Government Entomologist, The Government Agricultural Chemist, Lieut.-Col. T. Y. Wright, Sir Solomon Dias Bandaranaike, K.C.M.G., Dr. W. P. Rodrigo, Messrs. A. S. Long Price, H. W. Wilkinson, E. C. Villiers, J. W. Oldfield, D. S. Cameron, R. G. Coombe, C. B. Loudoun Shand, C. C. Du Pre Moore, D. S. Senanayake, J. E. P. Rajapakse, J. Ferguson, H. B. Daniel, M. H. Reeves, C. E. A. Dias, G. E. Jayatilleke-Hulugalle, and T. H. Holland (Secretary).

As visitors:—Dr. C. H. Gadd, Messrs. N. K. Jardine, F. P. Jepson, A. A. E. Beck, V. Canagaretnem, Chas. Gibbon, Felix R. Dias and P. A. Keiller.

Letters or telegrams expressing regret of inability to attend were received from the Hon. the Colonial Secretary, the Hon. the Controller of Revenue, Messrs. N. D. S. Silva, S. P. Blackmore, George Brown and Wace De Niese.

The minutes of the last meeting were confirmed.

Dr. W. P. Rodrigo made an enquiry regarding the alteration of the date of this meeting.

The Chairman in reply said that he had meant to open the meeting by an apology for the alteration of the date. Wesak had fallen on the proper day for the holding of the meeting and the date and time were altered solely on that account.

The Chairman then read a letter from Mrs. M. Kelway Bamber thanking the members of the Committee for their expression of sympathy on the death of her husband.

Agenda Item 1—Progress Report of the Experiment Station, Peradeniya.

Two reports were presented to the meeting; one for the months of January and February 1925 and one for March and April.

The Chairman briefly commented on these reports. With regard to green manures he said that the areas were being increased in order to cope with the demand for seed which at present greatly exceeded the supply.

He invited questions on the reports.

Mr. D. S. Senanayake suggested that the progress and other reports should in future be printed instead of duplicated.

Dr. W. P. Rodrigo supported this suggestion.

The Chairman replied that if the papers were to be printed by the Government Printer he thought there would be considerable difficulty in getting the work done in the time available. He promised however to consider how best the suggestion could be given effect to.

Agenda Item 2—Rubber Tapping Experiments on Experiment Station, Peradeniya.

Mr. Holland reviewed the report which had been circulated to members.

The Chairman then invited discussion.

Mr. R. G. Coombe enquired whether Brunolinum was used.

Mr. Holland replied that a 5% solution of Brunolinum was applied immediately before tapping in wet or doubtful weather; and in positive cases a 10% solution was applied in the afternoons.

Lieut.-Col. T. Y. Wright, referring to the old 2- vs. 3-day-tapping experiment, enquired if, when losses occurred on a plot, other trees were taken out of the experiment to equalise the number of trees in each plot.

The Chairman replied that this was not necessary as the results were expressed in yields per tree.

Lieut.-Col. T. Y. Wright further commented on the fact that in the case of some series a higher yield had been obtained from the higher portion of the panel than from the lower portion. He asked if any figures were available on the comparison of yields at different heights of the tree.

The Chairman promised to ascertain what figures were available.

Referring to the experiment in tapping on alternate days throughout the year and tapping daily in alternate months, Mr. Oldfield drew attention to the striking difference in the incidence of bark rot in the two methods of tapping and asked whether the Chairman drew any deductions from the figures.

The Chairman replied that he would not draw any definite conclusions from the results of a single experiment.

Mr. C. E. A. Dias proposed that the results of the experiment in tapping on alternate days throughout the year and tapping daily in alternate months should be sent to the Rubber Controller for his information and possible guidance in assessing production.

Several members questioned the utility of this procedure, while some members considered that all available figures should be sent.

A resolution that figures of rubber tapping experiments dealing with yields from trees tapped daily as against those tapped on alternate days should be forwarded to the Rubber Controller was eventually carried. 7 voting in favour and 4 against.

Agenda Item 3—Proposed Soil Erosion Experiments.

The Chairman reminded members that a Sub-Committee had issued a report on this matter last year. One of the recommendations of the Sub-Committee was that further experiments should be carried out by the Department of Agriculture. He thought it desirable that before starting on estates a trial set of experiments should be started on the Experiment Station. He had asked Mr. Holland to consider possible available areas.

Mr. Holland had drafted some suggestions as to these experiments and had some further remarks to make. The Committee should then decide which of the suggested methods of treatment should be adopted for the 6 plots available.

Mr. Holland said that the paper circulated to members was intended only as a basis for discussion. He reviewed some of the difficulties that would be encountered and gave his opinion as to the methods of treatment which he considered would be most usefully included.

Mr. R. G. Coombe enquired how far off one another the two suggested areas were, and if there was any possibility of the rainfall being different.

Mr. Holland replied that the areas were only about 200 yards apart.

The Chairman asked members to give their opinions as to which of the various suggested methods of treatment should be adopted.

Lieut.-Col. T. Y. Wright suggested that the plots should be manured and the silt analysed to determine the losses in manurial ingredients

The Chairman did not think that any results of value would be obtained from such small quantities of manures.

Mr. Coombe desired that a plot planted with Grevilleas should be included.

Mr. Cameron supported the suggestion and said that the Grevillea was the finest wash preventing plant we have.

The Chairman did not think that Grevilleas would be likely to be successful at Peradeniya but agreed to consider the proposal.

Mr. Oldfield thought that all plots should have drains, since drains were always found under working conditions.

Mr. Wilkinson advocated hedges of crossed dadap stumps.

The Chairman mentioned that in a previous set of experiments the least soil was lost from a plot covered with desmodium.

Mr. Holland said that selective weeding had been carried out over the plots in question for about 2 years; *Oxalis corniculata* was left untouched and now afforded a fair cover.

Mr. C. E. A. Dias advocated the trial of *Vigna oligosperma* as well as *Centrosema pubescens.*

The Chairman thought that only one plot under a creeping cover plant could be included.

After some further discussion it was agreed that it was desirable to try the following methods of treatment:—

Silt pits, envelope forking, Dadap hedges, a creeping leguminous plant, hedges of an erect leguminous plant, Grevilleas, contour lines of grass. The Chairman promised to consult with Mr. Holland and formulate a final scheme.

The Chairman then asked Mr. Wilkinson to speak on experiments on wash prevention that he had carried out on Talankande Estate, Lindula.

Mr. Wilkinson said that the paper which had been circulated to members had been originally written four months ago and he had since modified some of his opinions. He reviewed the contents of his paper.

The Chairman said that the Committee were very much indebted to Mr. Wilkinson for giving them the results of his trials. It was often difficult to answer questions as to the suitability of green manure plants for different districts and such information was of great value.

Agenda Item 4—The Control of Shot-Hole Borer by Manures.

Mr. Jepson reviewed the results of the experiments up to date which showed that manures, particularly nitrogenous manures, had a marked influence on gallery healing. The experiments bore out the general belief that the pest could be controlled up to a certain point by good cultivation and liberal manuring.

Mr. Chas. Gibbon suggested that the presence of Dadaps was the factor which had actually exerted the controlling influence.

The Chairman was not inclined to fully agree with this view.

Mr. Coombe expressed great appreciation of Mr. Jepson's work on Shot-hole Borer, and asked that a record be made of this appreciation by the planting community. He suggested that the various publications on the subject should be brought out in book form.

Mr. Daniel supported Mr. Coombe and said that Sarnia Estate had greatly benefitted by Mr. Jepson's work.

The Chairman associated himself with the appreciative remarks made on Mr. Jepson's work and promised to consider the possibility of bringing out a summary of all the departmental publications on Shot-Hole Borer.

Agenda Item 5—Tea Tortrix: the Present Position.

Copies of the reports received from the District Planters' Associations which had been circularised on this subject had been circulated to members.

The Chairman said that Mr. Jardine had consistently recommended the system of flight breaks and it was the intention of the Department to arrange trials of the efficiency of flight breaks by means of jute hessian screens or similar contrivance during the coming Tortrix season.

Mr. Oldfield said that the report of the Maskeliya Planters' Association Sub-Committee had been adopted by the Planters' Association and had been forwarded to the Ceylon Estates Proprietary Association, which body was issuing instructions to the estates controlled by their members to carry out the recommendations.

Agenda Item 6—Supplying Old Tea.

The discussion of this item was postponed owing to the absence of Mr. George Brown.

Agenda Item 7—Breeding of Flies in Manures.

Mr. Jepson reviewed the results of his experiments at Hunupitiya Works and elsewhere which showed conclusively that flies did not breed in dry manures in the condition in which they were despatched from the Works, but that after spreading on the estate flies were bred in large numbers in mixtures containing fish. If the manures got wet in transit the result might be different.

Mr. P. A. Keiller of the Colombo Commercial Company, who had been associated with Mr. Jepson on the conduct of the experiments, made a few remarks on his experiences. He was carrying out further experiments which tended to show that the presence or absence of fish guano was the controlling factor in attracting flies.

Mr. Coombe gave it as his opinion that owing to the difficulty in obtaining fish guano this year the plague of flies in Badulla was very much lessened.

Lieut.-Col. T. Y. Wright suggested that the attention of the General Manager of the Railways be drawn to the possibility of the breeding of flies resulting from manures getting wet in transit.

The Chairman said that the final results of the experiments were now being written up but he had asked Mr. Jepson to make a brief statement as he thought the early publication of the results would be of interest to Agriculturists. The Department was much indebted to the Colombo Commercial Company and in particular to Mr. Keiller for the assistance given.

Agenda Item 8—Report on Oil Palm Nuts from Ceylon.

The Chairman commented on the report of the Crown Agents for the Colonies which had been circulated to members. The report dealt with the handling of a consignment of oil palm nuts from the Anuradhapura Experiment Station by machinery erected by the Nigerian Products Company, Ltd., at Wembley.

The Chairman gave it as his opinion that the oil palm required practically the same conditions as the coconut palm and it was unlikely that any advantage could be gained by substituting the former. The native method of dealing with Palm Kernels on the west coast of Africa was a tedious and laborious business and was not likely ever to become popular locally. The overhead charges for machinery, etc., were so high that it would not be profitable to plant less than a thousand acres. He thought that possibly some of the land along the new Batticaloa railway might be suitable for oil palms and he was proposing to Government the establishment of some trial plots.

Agenda Item 9—Bud-Rot of Coconuts.

Dr. W. P. Rodrigo asked for information as to the causes of Bud-rot of coconuts and possible remedies.

Mr. Petch replied that there were two kinds of Bud-rot, one caused by a strain of the bacillus coli and one by a Phytophthora fungus. He gave reference to works on the disease in other countries and said that Dr. Gadd was now working on the bud-rot of areca and coconut palms.

Dr. Rodrigo asked if there was any truth in the belief that the dung of the jungle crow was responsible for the disease.

Mr. Petch did not think so.

Dr. Rodrigo asked if any inoculation experiments had been carried out.

Mr. Petch replied that none had been carried out in Ceylon.

Dr. Rodrigo asked if the disease was infectious or contagious.

Mr. Petch replied in the affirmative. With regard to remedies it was possible to trim up the crown and remove the diseased tissue.

Dr. Rodrigo said that he had observed that part of his estate which was under mimosa was free from bud-rot, while the disease had occurred in a portion which was clean weeded.

Mr. C. E. A. Dias professed to have cured bud-rot by the application of copper sulphate.

Dr. Rodrigo objected that the disease was not observed till the tree was dying.

Mr. Petch said that once the bud was attacked the tree was doomed and should be cut out and burnt, but the disease first attacked the central spike, and if it was then observed it might be possible to save the tree.

Agenda Item 10—Nitrogenous Manures for Coconuts.

Mr. J. E. P. Rajapakse said that owing to the high prices of nitrogenous manures he was anxious to obtain the opinion of members as to the most economical manure at present on the market.

Mr. Joachim said that the choice of a manure depended on soil and climatic conditions. Nitrogenous manures could be divided into organic and inorganic manures. He explained the unit system of estimating the value of manures and said that, at present prices, of the inorganic manures, Calcium cyanamide provided nitrogen at the cheapest unit cost, while, of the organic manures, blood meal was the cheapest.

Mr. Dias made some observations on a disease of coconuts which had appeared to be attributable to the application of fish guano.

Mr. Rajapakse on the other hand attributed good crops and healthy trees to fish guano.

The Chairman said that in the absence of any Coconut Experiment Station the Department of Agriculture was unable to give any further information on the subject.

At the conclusion of the agenda the Chairman said that this was the last meeting at which Mr. Petch would be present. He wished to move that the Committee expresses its high appreciation of the services rendered by Mr. Petch to the Agricultural Community over a period of 20 years and tenders its best wishes for his period of retirement. He thought that a

group photograph would form a suitable memento to Mr. Petch and had made arrangement for one to be taken at the conclusion of the meeting.

Mr. Oldfield on behalf of the Planters' Association paid a warm tribute to Mr. Petch's work for the Planting Community.

Mr. Dias on behalf of the Low Country Products Association endorsed Mr. Oldfield's remarks.

Mr. Petch in reply expressed his regret at leaving his work and his indebtedness to the Planting Community and to Agriculturists in general for the assistance they had always given him.

A group photograph was then taken with Mr. Petch as central figure.

T. H. HOLLAND
Secretary,
Estates Products Committee.

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA.

For the Months of January and February, 1925.

TEA.

The crop has been poor. 2,696 lb. of green leaf was plucked from 11 acres in January and 2,426 lb. in February, a total of 5,122 lb. against 7,870 lb. in the two previous months.

The dadaps in plot 144 and 149 have been cut and mulched after an interval of three months yielding 6,460 lb. and 2,040 lb. green mulch respectively. The Gliricidia maculata in the half-acre plot was lopped and yielded 7,140 lb. of mulch per acre equal to 42 lb. per tree. The dadaps in the ½-acre plot was lopped and yielded 4,080 lb. of mulch per acre equal to 24 lb. per tree.

The ½-acre tea plot was manured for the 2nd time in January according to the scheme. A census of vacancies has been taken for planting up during the monsoon rains.

All drains and boundaries have been cleaned.

RUBBER.

Tapping was commenced on January 2nd on 11-year-old trees in plots 63-67 above the B cacao and plot 140 D behind the store lines. Individual tree yields are being recorded in plot 140 D.

In plot 151-154 Series 1, 3 and 5 (alternate-day tapping) the tapping has been changed over to a new panel on renewed bark after six years from 1st February. A complete census of trees affected by Brown Bast and other diseases was taken in January. These will appear in the reports on the experiments concerned at the end of March.

CACAO.

Two pickings have been taken. The autumn crop is nearly finished and the prospects of a spring crop are good.

Three blocks of 10 acres each have been treated for stem canker

as follows :—

1st block by lightly scraping off the cankered bark and rubbing on crystals of copper sulphate.

2nd block by scraping and painting with 10% Brunolinum.

3rd block by scraping and applying a standard solution of copper sulphate.

Comparative costs have been kept.

COFFEE.

The demand for seeds and plants of the Robusta types continue. Dry berry fetched 29 cents per lb. at the last auction sale. This was the highest offer received. Over a 1,000 lb. have been sold. The small manuring experiment instituted in plot 140 E was reported in January, Plot 1 was manured with cattle manure forked in all over the ground—200 lb. per tree or approximately 15 tons per acre.

Plot 2 was mulched with dadap leaves, 200 lb. per tree or approximately 15 tons per acre. Plot 3. Plain forking with burial of existing mulch.

All die backs and suckers on the main stem have been regularly removed.

COCONUTS.

The young palms along the river bank are making vigorous progress. The dwarf palms planted near the ferry are not looking healthy.

FODDER GRASSES.

Buffalo grass and native paspalum received from the Department of Agriculture, Southern Rhodesia and planted in nursery beds in the Fruit plots are growing well. The plot of Efwatakala grass (Melinis minutiflora) planted near the Bandaratenne culvert has been extended. The grass is doing well and appears to be promising.

A plot of Pennisetum purpuriscens has been planted along the river bank near the Getambe ferry.

GREEN MANURES AND COVER PLANTS.

Indigofera endecaphylla.—The plot of Indigofera endecaphylla planted in the avenue rubber has been extended up the steep portion The seed is being collected and supplied to applicants in limited quantities for trial.

Vigna oligosperma.—A plot of Vigna oligosperma has been planted from cuttings in the avenue rubber.

Pueraria javanica.—Two plants have been found to be growing in this Show plot—one with a yellow flower and the other with a red flower. These were sent to the Botanist and Mycologist who identified them as *Phaseolus calcaratus* (yellow flower) and *Pueraria phaseoloides* (red flower). He recommended that a plot of the former be established.

Crotalaria anagyroides is doing well and has reached a height of 9-10 feet. It has begun to flower and seed four months from planting.

Centrosema pubescens.—A small quantity of seed of this quick growing cover crop is available.

Tephrosia vogelli seems very promising. It has made quick growth and formed a dense leafy cover, effectively checking the growth of weeds. The plants will be cut before flowering.

New beds have been planted with *Crotalaria laburnifolia*, *Indigofera hirsuta* and *Phaseolus calcaratus*.

Two plots of *Clitoria cajanifolia* have been cut for the first time and yielded 31,800 lb. and 36,700 lb. of green material per acre respectively.

GENERAL.

Bunchy top experiments. Healthy plantain suckers were replanted between the old rows of plantains and the manurial treatment repeated.

Maniocs. Two rows of each of the following manioc varieties have been replanted in the plot near the Bandaratenne culvert :—

Ubi Putch, Cassava Beureum, Mama Lenfi (Trinidad), Trinidad Smallings, Singapore, Trinidad Butter stick.

The weather has been very dry.

Rainfall for January was 10·27 inches in 10 days and for February 2·42. inches in 6 days.

(Sgd.) H. A. DEUTROM,

Acting Manager, Experiment Station, Peradeniya.

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA.

For the Months of March and April, 1925.

TEA.

Manures were applied to the plots under experiment in favourable weather in April. The tea is looking well.

RUBBER.

In the experiments started in April, 1922, in the Hill-top and Hill-side rubber the first change-over was made in April after 3 years' tapping.

Manuring of the plots under experiment was started at the end of April. Up to 1923 the manures were applied in trenches 3 ft. wide and 6 in. deep between the two rows of trees under one treatment ; in 1923 the trenches were dug across the rows between alternate trees ; in 1924 across the rows in the spaces not manured in 1923. This year the trenches have been dug down the rows again.

CACAO.

Lopping of dadap shade was completed. Pruning was started in March and finished at the end of April.

The crop from the whole cacao area of 39½ acres for the year ending March 31st, 1924, as measured by actual crops of dry cacao in store was 2·26 cwt. per acre of good cacao and ·82 cwt. of black cacao, a total of 3·08 cwt. per acre. If the crop of good cacao is calculated at 1,300 good pods 1 cwt. of dry cacao—the method used in past experiments—a total of 2·50 cwt. of good cacao is arrived at ; showing that last year the pods must have been bigger, and therefore fewer were required to make 1 cwt. of dry cacao. The numbers of good pods actually required to make 1 cwt. of good cacao in the three previous years were 1,328, 1,391 and 1,593 (in the wet year 1923-24).

COFFEE.

Cattle manure at the rate of 1 basket per bush was applied to a portion of the 6-acre coffee field. It is intended to manure the whole field when labour allows.

GREEN MANURES AND COVER PLANTS.

The following is a summary of the present position of some of the cover plants now being grown on the station :—

CREEPING PLANTS.

Indigofera endecaphylla.—Excellent cover has been formed under young rubber in the New Avenue rubber: the plant is easy to propagate from cuttings. Limited number of cuttings are available. It seeds freely but no seed is at present available.

Centrosema pubescens.—A good cover has been established from seed in the New Avenue rubber, but germination was patchy, and growth slow. Seed has been obtained but all is required at present for multiplication.

Vigna oligosperma.—Affords an excellent cover when established. Establishment of cuttings was at first unsuccessful; later whole bunches of cuttings were put in June, 1924, and though in August the plot appeared practically a failure, good growth was made in the north-east monsoon and a thick cover is now established. Seeds only very sparsely at Peradeniya. Establishment in the New Avenue rubber from seed was a partial failure; the block is now being replanted from cuttings. No seed, and only a very limited supply of cuttings at present available.

Pueraria phaseoloides.—*Pueraria javanica* has a vigorous leafy growth and seems likely to prove one of the most valuable cover plants we have. It has been successfully propagated from cuttings. Multiplication from cuttings is in progress.

SHRUBBY PLANTS.

Crotalaria angyroides has produced a magnificent growth 7 ft. to 9 ft. high and very leafy. It appears superior to *Crotalaria usaramcensis* which has given such excellent results on the station. Seed is now being collected.

Desmodium gyroides.—The growth though healthy is poor and patchy. The plant appears to have two habits; where germination has been thin it creeps and roots at the nodes, where germination has been thick it grows erect.

Clitoria cajanifolia.—Certainly one of the most hardy and valuable plants on the station. Contour hedges have been successfully established on two very poor bare washed banks where nothing else could be induced to grow. Will stand constant lopping at any time of year. Very deep rooted.

Tephrosia Vogelii has produced in 5 months a very fine leafy growth 8 ft. to 7 ft. high in a show plot and a fair growth in the Annual Economic area. Has not flowered yet. Appears superior to Tephrosia candida.

The following plants have been tried under old rubber but, though in some cases a certain amount of early growth was made and though in many cases of protection from snails was given (which would not be possible under estate conditions), in no case has sufficient cover been formed to be of the slightest use. The soil is good and the land almost flat :—

Indigofera endecaphylla
Centrosema pubescens
Vigna oligosperma
Desmodium triflorum
Desmodium heterophyllum

GENERAL.

Mr. T. H. Holland resumed charge of the station in April. The position as regards couch and illuk is slightly improved as the result of an increased grant at the end of the financial year 1923-24. It will however be difficult to maintain this improvement with the present funds. The labour force has been suffering from a prolonged epidemic of chicken pox entailing an average absence of 10 coolies per day.

T. H. HOLLAND,
Manager, Experiment Station, Peradeniya.

GENERAL.

THE EFFECT OF GRASS ON TREES.

A. HOWARD, C.I.E., M.A.

Summarised for the Tropical Agriculturist by A.W.R. Joachim, B.Sc., Chemist, Department of Agriculture, Ceylon.

I. INTRODUCTION.

Although trees flourish generally when surrounded by communities of grasses and herbs, cases have been known to occur in which grass is able to supress certain species of trees. One such example is that investigated by Bedford and Pickering at the Woburn Experiment Station where it was found that fruit trees such as apples, pears, plums and cherries failed to flourish under grass on a heavy clay soil. Forest trees are better able to resist the effect of grass than fruit trees. Thus in the tropics, grass-land after enclosure becomes covered by shrubs and trees with remarkable rapidity.

The injurious effect of grass on trees was attributed by Bedford and Pickering to a soil toxin produced by the growth of grass and which acted as a poison towards the roots of trees. This soil toxin has never been isolated. It was found to disappear in a very short time when the drainage water containing it was aerated, and was not observed on permeable, well-aerated soils. The problem therefore needed further investigation. Since 1914 the influence of grass on trees has been the subject of investigation at the Pusa Research Institute. Two problems have been kept in view, namely, (1) why grass is so injurious to fruit trees; (2) the nature of the weapons by which forest trees vanquish grass.

(1) *The factors.*—Pusa is situated on the old alluvium of the Gangetic plain. The soil is a highly calcareous, silt-like loam. There is no line of demarcation between soil and sub-soil. The percentage of Calcium Carbonate is over 30. The phosphate content is below the average. Nitrogen shortage is rectified by the addition of organic matter. The water level is 20 feet below the surface. The average rainfall is 47'5 in., most of which falls during the monsoon period (June 15th to October 15th). The temperatures of air and soil begin to rise from about the middle of February till the end of May.

(2) *Growth of Trees and Grass at Pusa.*—In the case of trees flowering the production of new leaves and shoots takes place during the hot season (March to May). The growth of grass corresponds, with one exception, to the growth of trees. In the hot dry months of March, April and May, grasses cease to grow when there is no competition between the grass and trees.

(3) *The Experimental Fruit Plot.*—In 1914, eight species of fruit trees were planted out in three acres of uniform land. Twenty-four trees of each kind, raised from a single parent were set out 20 feet apart each way. The trees

were:—1. Plum, 2. Peach, 3. Custard apple, 4. Guava, 5. Mango, 6. Litchi, 7. Sour lime, 8. Loquat. Two years after planting (1916) when the trees were fully established, a strip about the middle of the plot comprising nine trees of each of the eight species was laid down to grass—*Cynodon dactylon*. The two end plots served as controls.

In 1917, three years after planting, when the grass was well established and its injurious effects on the young trees was clearly marked, the three southern trees of the grass plot were provided with aeration trenches, 18 inches wide and 24 inches deep, filled with broken bricks. Three trenches were made at equal distances between the lines of trees. In 1921 to ascertain the effect of grass on established trees in full bearing, the southern strip of the northern control plot was grassed over and has been so since.

The harmful effect of grass on fruit trees at Pusa was found to be more intense than on clay soils like those of Woburn in Great Britain. Several species were destroyed altogether within a few years. As great differences in root development were observed between the trees under grass, under grass with aeration trenches, and under clean cultivation, the first step in investigating the causes of the harmful effect of grass was a study of the root-system (under clean cultivation) and correlation of this with the growth of the above-ground portion of the trees. Detailed work was carried out in 1921 and was repeated in 1922 and 1923.

II. THE ROOT SYSTEMS OF FRUIT TREES UNDER CLEAN CULTIVATION.

The root systems of three deciduous trees, the plum, peach and custard apple were studied.

The plum has a two-root system firstly the superficial and consisting of large, freely branching roots running more or less parallel to the surface in the upper 18 inches of soil. From the under side smaller members are given off which grow vertically downwards to just above the water-table. During the hot period root absorption is confined entirely to the deeper layers of soil. In heavy monsoonic weather only the surface roots are active.

The root system of the Peach is similar to that of the Plum.

The Custard apple flowers in early April and the fruit ripens in August and September. The root system is similar to that of the plum and the peach.

The root systems of the Mango, Guava and Litchi—ever-greens—resemble in many respects those of the three deciduous species already described. The large superficial roots give off smaller branches to the deep soil layers which maintain the growth in hot season. The early rains bring the surface roots into action.

In the Guava the reddish roots are very strongly developed. There is an abundant superficial system which gives off numerous branches which grow vertically downwards. As in the plum, peach and custard apple the whole of the root system was found to be active at the beginning of the hot weather. Irrigation during hot weather is a decided advantage.

New growth of the Litchi begins in December, flowering takes place in February and the fruit ripens in May. As in the mango, the extensive

superficial roots give off branches which pass down into the deep soil layers. The deep root system, however, is not so strongly developed as in the mango, hence it is grown where the ground water is comparatively near the surface.

The root system of the Lime is similar to that of the Litchi.

The Loquat flowers twice a year, first in August and again in January and February. Only the latter flowers set fruit. The loquat has two root systems and the periodicity of root activity closely resembles that of the Mango.

III. THE INJURIOUS EFFECT OF GRASS ON FRUIT TREES.

This varies with the species and with the period of life of the trees when grass was planted. Young trees are more adversely affected than fully developed individuals. Deciduous species suffer more than evergreens.

(1) *The Effect of Grass on Young Trees.*—The custard apple is the most sensitive of the young trees studied. The trees were killed within two years after the grass was planted. Next in order of susceptibility were the loquat, plum and the lime, all of which were killed by grass. The peach, litchi, mango and guava are the most resistant. In addition to restricting the amount of growth, grass affects the leaves, branches, old wood and fruit, as well as the root system. The foliage produced under grass appear smaller, yellower and fall prematurely. The trees under grass flower late and sparingly. The fruit is small, tough, very highly coloured and ripens earlier than usual.

The effect of grass, except in the guava, on the superficial system is to restrict greatly the total amount of root development, to force the roots downwards below the grass, and to reduce the amount of active rootlets during the monsoon.

The grass has no appreciable effect on (either) the development or the activity of the deep roots.

Grass not only affects the roots underneath, but also the development of those of the neighbouring trees under cultivation. Such roots either turn away from the grass, or else turn sharply downwards before they reach it.

Two conclusions can be drawn from a study of the root system .—(1) Trees under grass are able to form the deep root-system and to make use of the moisture and minerals in the lower soil layers as in case of trees under clean cultivation. (2) In the second place, trees under grass (except in the case of the guava) form a very weak superficial system and produce but few active rootlets in the surface soil. The contrast between the trees under cultivation in this respect is very striking and significant.

The Effect of Grass on Established Trees.—The damage is less than in the case of young trees but the order of susceptibility is very much the same. At first the grass grew poorly, but with the rains a carpet was formed, and the effect became more marked.

Similar effects were observed as in the case of young trees under grass, viz., a greatly restricted development of absorbing roots on the surface

system compared with the controls. There were no differences in the dormancy or activity of the deep root-system.

The Effect of Aeration Trenches on Young Trees under Grass.—There was no effect on the custard apple or lime, both of which died. The aeration trenches markedly increased growth in the litchi and the mango. The root-system showed superficial roots much larger and better developed than those under grass, except in the guava where no difference in size could be detected. The roots were attracted towards the trenches. The trenches develop the deep-root system, as is to be expected. Even the temporary removal of the grass leads to a profound effect, viz., an immediate increase in growth, accompanied by the formation of larger and darker coloured leaves.

The experiments showed—

(1) The extremely deleterious effect of grass on young trees.

(2) The less harmful effect of the same treatment on mature trees.

(3) The partial recovery which resulted from the aeration trenches particularly in the case of loquat, mango and litchi.

(4) The failure of the aeration trenches to save plums, limes and custard apples.

(5) The exceptional nature of the results with the guava, where the trees were able to grow under grass, but with reduced vigour and where the aeration trenches had little or no effect.

IV THE CAUSE OF THE HARMFUL EFFECT OF GRASS.

A study of the root-system showed— (1) the grass affected the superficial system only and had little or no effect on the deep roots. Only in the guava, which is the least susceptible to grass, was anything like a normal superficial system developed. The general effect of grass was to check the growth of the surface roots and to reduce greatly the number of active rootlets.

(2) The various root systems exhibited a remarkable reaction to improved aeration.

(3) As soon as the surface system become active in the early rains, there was a marked increase in the growth of the leaves and shoots. This was a period of active nitrification. A similar, but far less pronounced increase took place in the trees under grass. Grass was harmful in two ways (1) by restricting aeration of the surface roots in the monsoon, (2) reducing the supply of combined nitrogen.

The effect of two other factors—soil temperature and soil moisture—which may possibly have operated were examined, but gave negative results.

The advantage to the trees of the increased aeration provided by the trenches suggested that an examination be made of the soil gases. Determinations of the amounts of Carbon dioxide in the soil air at a depth of from 9 to 12 inches were carried out during 1919 under grass, under grass with aeration trenches and under cultivated soil.

It was found that the grass increased the amount of Carbon dioxide in the soil air and particularly during the rains, at a time when the superficial root system was most active. The trenches improved the aeration. The

presence of Carbon dioxide, and not the diminished oxygen supply, was therefore the harmful factor. During the monsoon the volume of Carbon dioxide in the pore spaces under grass was increased about five-fold in comparison with the soil air of cultivated land. Carbon dioxide being far more soluble in water than oxygen, it is probable that the root-hairs are actually subjected to a very much higher percentage of Carbon dioxide. This is but one factor of several which might cause the harmful effect on the fruit trees. Apart from this the presence of grass is bound to influence the supply of food materials. On analysis of the nitric nitrogen in the top 18 inches of soil, it was found that the combined nitrogen was defective. The grass carpet does reduce very considerably the amount of nitric nitrogen. This in land under grass was found to be only 10 to 20% of that in clean cultivated land. The second effect of grass on fruit trees therefore was the diminishing of available nitric nitrogen in the soil.

A third possible reason for the harmful effect of grass on fruit trees was the presence of a soil toxin produced by the grass. An experiment was tried with the guava—the roots of which could withstand large quantities of Carbon dioxide in the soil air—to ascertain whether the harmful effect of the grass was due to a soil toxin. The defect due to the nitric nitrogen factor was eliminated by the addition of sulphate of ammonia at the rate of 10 cwt. to an acre. The response was immediate—the leaves increased in size, the internodes lengthened and the colour of the foliage deepened in tone. This proved that no soil toxin was formed, but that in the guava the harmful effect of grass was due to its interference with the supply of combined nitrogen.

In the case of the litchi and the loquat the roots of which are unable to aerate themselves during the rains, the harmful effect remained even after the addition of nitrate of soda at the rate of 900 lb. per acre.

The harmful effect of grass on fruit trees seemed to be due therefore to two causes, both of which were related to the aeration of the soil. (1) The direct effect due to accumulation of large quantities of Carbon dioxide in soil; (2) the greatly diminished supply of combined nitrogen—one of the consequences of the long continued growth of grass.

V. FOREST TREES AND GRASS.

The relations between grass and a number of common Indian Forest trees were under observation at Pusa for the last three years, and an attempt was made to ascertain the nature of the weapons by which these trees were not only able to thrive under grass but to vanquish the grass in free competition.

The trees flower and come into new leaf in the hot weather, but a distinct visible change is noticeable in the colour and appearance of the foliage after the first rains. A study of the root system showed:—(1) that the superficial roots functioned in wet weather, (2) abundant active, normally developed rootlets in the upper two or three inches of soil which competed successfully with grass for minerals and oxygen, (3) that the deep root system functioned in the dry weather.

The chief weapons of forest trees to oust grasses and herbs are therefore (1) the deep root system which admits of growth during the dry

season when the grass is dormant and enables the trees to utilise moisture and food materials in the soil down to at least 20 feet; (2) The habit of the trees—a great advantage in the struggle for light. (3) The active roots of the surface system which are resistant to poor soil aeration and are able to successfully compete with grass for oxygen and minerals.

The surface roots of forest trees resist the harmful effects of the atmosphere of Carbon dioxide, unlike those of fruit trees.

SUMMARY.

Experiments carried out at Pusa since 1914 by A. Howard to test the effect of grass on fruit trees have demonstrated the following :—

(1) That grass is injurious to fruit trees, several species of the latter being killed as a result of establishing a cover of grass on an area of young fruit trees, some of the species being more susceptible than others.

(2) Young trees are more susceptible to the harmful effects of the grass than those fully established.

(3) Aeration trenches in the case of some of the species render the effect of the grass less injurious.

The causes of the harmful effect of grass were ascertained by (1) a study of the root systems of the different species under clean cultivation, under grass, and under grass with aeration trenches; (2) the analysis of the soil air, (3) manurial experiments.

This harmful effect has been ascribed to the following causes :—

(1) The accumulation of large quantities of Carbon dioxide in soil under grass.

(2) The greatly diminished supply of combined nitrogen.

The injurious effect of grass is not due to the presence of soil toxins. Forest trees are able to flourish in soil under grass, as their surface roots are able to resist the harmful effects of the Carbon dioxide of the soil, and their natural habit enables them to take full advantage of the light.

RAILWAY STATION GARDENS.

THEIR MAKING AND UPKEEP.

H. F. MACMILLAN, F.L.S., F.R.H.S.

Superintendent of Botanic Gardens.

Railway Stations are often capable of affording, in addition to their primary objects of utility and attractiveness to the Railway, excellent opportunities of establishing useful little gardens, sometimes in isolated or sparsely cultivated localities, which serve as object-lessons to the neighbours or travellers. Moreover, the most cheerless and bleak situation may be converted into an attractive and interesting home by due attention to the cultivation of flowering or ornamental plants, trees, &c., suited to the locality, whilst the effect of such gardens in rendering a vicinity salubrious and agreeable can be readily conceived.

Planting Boundary Trees for Shade or Shelter.—The outline of the garden having been decided upon, the boundary should be planted with suitable trees for the purpose of providing shade, or shelter if in a windy situation. These must not be planted too close to the platform, as otherwise the branches may interrupt the view of the drivers, and are, therefore, liable to be hacked or mutilated. Evergreen, rather than deciduous, trees should, as a rule, be planted for shade, as the latter are liable to drop their leaves when shade is most required. It is not sufficient merely to plant these out and then allow them to look after themselves. Large deep holes filled with good soil and some well decomposed manure should be prepared before planting out, which should be done in wet weather. Each plant should afterwards be staked, shaded and fenced. Watering, morning and evening, must be attended to if the weather is dry, until the plants are well established.

Laying out the Garden.—First sketch on paper the general scheme it is proposed to follow; then mark this off on the ground with string and pegs. The plan should, of course, depend on the extent and nature of the ground as well as on the permanent staff available for carrying on the work. Never make a garden larger than you are likely to be able to maintain in good condition. A small garden well kept is obviously preferable to a larger one which always presents an untidy or neglected appearance. Station Masters in Ceylon frequently overlook this fact and seem to have a preference for numerous miniature beds and borders, often but a few inches in width, clustered round each other. For beds and borders, manuring is essential, and although manure is often scarce a resourceful Station Master can usually manage to obtain his requirements. A supply of water is also of course indispensable.

Complicated geometrical figures or fantastic designs are neither ornamental nor practical, being unsuitable for the growth of ornamental plants and too small and intricate to allow of their being properly worked. These should be discouraged in favour of beds of moderate dimensions and simple outline, as round, oval, square, or diamond shapes.

Borders, which are often more suitable for station gardens than beds, should not be more than about 4½ feet in width. They form a striking background if planted with tall shrubs at the back and with gradually smaller plants in front. Care should be taken to keep the foreground as open as possible and to avoid obstructing the view.

Importance of a Lawn.—Whenever the area is sufficiently spacious, as much lawn as possible should be introduced, in fact it is hardly possible to have too much lawn. A well-kept piece of lawn, in which are dotted a few beds of flowering plants, has a special charm. A lawn, moreover, is easily made, and does not involve much labour in upkeep. Yet it is seldom seen at stations in Ceylon. In making a lawn, the ground should be dug and the surface uniformly levelled and made smooth; roots of any fine grass obtainable in the vicinity may be dibbled in 3 or 4 inches apart, watering the ground well afterwards, as well as before planting if dry. When the turf is well established the grass must be kept short, which can easily be done with an edged bamboo splint if a lawn-mower is not available.

General Design or Plan.—Where only a narrow strip of ground along the platform is available, no elaborate design should be attempted. In this case a mixed border, 3½ to 4½ feet wide, consisting of ornamental shrubs for a background, and finishing with smaller plants in front, is the most practical and effective arrangement. The ideal station garden should present a striking background of ornamental shrubs, backed by shady flowering

trees, with, if space permits, a few beds of small showy plants in the foreground set out in a smooth, level lawn. This will present the best effect as seen from the platform or the Railway carriages.

Paths.—These should not be less than 3½ feet in width, and may be either straight or gracefully curved. It must be remembered that they are meant for convenience rather than ornament; therefore avoid having any more than are necessary. Smooth lawn looks better than paths, and is easier to keep in order. In some places, however, paths are a necessity, and when these are of uniform and ample width, with neatly trimmed edges, they add to the general effect of a garden.

Hedges and Fences.—It is essential at the outset to guard against vermin and wandering cattle, also, in some places, against deer, porcupine, &c., so that protection by means of a wall, a paling of old sleepers, or a good barbed-wire fence is usually indispensable. When such is employed it should be concealed and beautified by showy climbers, or by a neat hedge of ornamental shrubs. A live double hedge of some formidable prickly plant, as Bromelia, Thorny Agave, &c., may, in some cases, afford an efficient barrier when well established, but it is usually necessary to reinforce it with a wire or other fence of some kind. It is well to remember, however, that no fences may be put up by the Railway staff without the sanction of the superior officer in charge.

Climbers.—Ornamental climbers can be used with charming effect over arches of bamboo or old rails or sleepers; or they may be made to twine round tree trunks or trained in festoons between pillars. They may also serve useful purposes in screening off an unsightly outhouse or shading an exposed verandah. Climbers, however, like trees may be injurious to buildings if allowed to grow unchecked over the roof, and should, therefore be kept within bounds.

Upkeep.—However well a garden may be laid out and planted, its attractiveness will depend entirely upon how it is looked after or kept up, and as a rule it may be accepted that the condition of a garden invariably reflects the extent of personal interest of the person in charge. Keeping the grass short and the turf uniformly level, the paths and platform clean-weeded and rolled, with neatly cut edges, hedges neatly trimmed, attention to weeding, forking, and mulching the soil, all go far to make a perfect garden.

Propagation.—There is no reason why each Station Garden should not do simple propagation by cuttings or by division of roots or bulbs, instead of allowing valuable plants to die or run out of stock and expect the Botanic Gardens to replace them when required. All that is necessary is a bed of loose rich soil in a shady corner. This should be dug to about 2 feet deep, so as to afford good drainage and retain moisture in the soil during dry weather. On the top, place a layer of fine soil, to which some leaf mould and fine river sand should be added. Very little attention is required beyond shading and watering, when necessary, and frequently forking up the surface soil. The advantages of having one's own little nursery are obvious, for not only are the plants ready at hand when required for planting out or for filling vacancies, but the supply of special kinds suitable for definite purposes or locality can be relied upon. Some plants, as Coleus, Alternathera &c., strike roots so readily that they may be planted out from cuttings where intended to grow.

The following selections of plants are intended to serve as a guide as to the kinds that may be chosen for the gardens at different elevations. To these many others may be added to suit the circumstances or special

locality. For larger selections, with illustrations and fuller descriptions, classified according to elevation and climate, the reader is referred to Macmillan's *Tropical Gardening and Planting*, 3rd edition :—

Selected Flowering and Foliage Plants, Annuals, Climbers, &c.

(Suitable for Gardens from Sea-level to 6,000 ft. Elevation.)

FLOWERING AND FOLIAGE SHRUBS, 5 ft. to 8 ft. HIGH.

Lagerstroemia indica.—"Indian Lilac." Flowers pink.

Tabernaemontana coronaria.—Flowers pure white. Known as "Wax-flower."

Croton.—Different varieties. Ornamental foliage ; suited for hedges, &c.

Palms.—Different kinds. Handsome graceful foliage.

Acalypha.—Different varieties. Large coloured leaves,—crimson, bronze, yellow, &c.

Pisonia alba (Lettuce-tree).—Greenish-yellow foliage ; specially suited to seaside.

Arundo Donax—Large variegated grass.

Hibiscus.—Different varieties. Showy flowers ; suited to seacoast.

Amomum magnificum.—Ornamental leaves, showy flowers.

Poinsettia pulcherrima.—Showy scarlet flowers ; very striking, lasts long in blossom.

Heliconia aureo-striata.—Large ornamental plantain-like leaves.

Panax fruticosum.—Ornamental feathery leaves.

Cordyline (Dracaena).—Ornamental, bronze, or crimson leaves.

Aralia filicifolia.—Ornamental feathery leaves, yellow when young.

Mussaenda erythrophylla.—Showy scarlet flowers ; lasts long in blossom.

Gardenia florida.—White, scented flowers ; a general favourite.

Kopsia fruticosa.—Pink and white flowers.

Plumeria rubra.—Temple-tree. Crimson flowers ; suited to seacoast as well as inland.

CLIMBERS.

Solanum Wendlandii.—Giant potato-creeper, blue flowers ; very showy.

Allamanda Hendersonii.—Large yellow bell-shaped flowers.

Bignonia magnifica.—Beautiful magenta flowers.

B. unguis.—Bright yellow flowers.

Cissus discolor.—Pretty, satiny-coloured leaves.

Antigonon leptopus.—Pink flowers.

Clerodendron Thomsonae.—Beautiful white flowers with scarlet corolla tips.

Petrea volubilis.—Beautiful blue and violet flowers.

Congea tomentosa.—Showy pink flowers in large sprays.

Sea Level

1,500 ft.

LOW PLANTS SUITABLE FOR BEDS, FRONT ROWS, OR EDGING.

Cannas.—Numerous varieties. Flowers yellow, scarlet, pink, &c. Leaves large, green, or bronze.

Vinca rosea.—Pink or white flowers.

Coleus.—Different varieties. Ornamental foliage. Fresh cuttings should be planted at frequent intervals.

Caladiums.—Different varieties. Ornamental foliage.

Aster or "Michelmas Daisy."

Alternathera.—Several varieties. Dwarf plants, useful for edging.

Ageratum.—Blue flowers.

Angelonia.—Bluish-purple flowers.

Cosmos.—Pink and white flowers.

Ananas variegata.—Ornamental variegated foliage.

Turnera elegans.—Creamy-white flowers, closing in afternoon.

Gynandropsis.—Large pink blossom.

Torenia Fournieri.—Small plant, violet-blue and white flowers.

Chrysanthemum, perennial.—White-flowered varieties the best.

Gomphrena globosa.—Purple flowers.

Phrynium variegatum.—Ornamental variegated foliage.

Pentas carnea.—Free-flowering, different shades.

Ruellia colorata.—Purple leaves, perennial, creeping.

Salvia farinacea.—Blue flowers.

Salvia splendens and **var's**—Scarlet, blue, or purple varieties.

Petunia.—Showy purple or white flowers.

Cuphea jorullensis.—Flowers orange yellow.

Marigolds.—Flowers showy, yellow, orange, &c.

SHOWY FLOWERING ANNUALS.

Acroclinium.—Everlastings, pink and white.

Asters (Annuals), different shades.

Balsams.

Browallia.

Celosia, or Cock's Comb.

Chrysanthemums (Annual).

Clarkia.—Pink flowers

Candytuft.—White or purple

FLOWERING AND FOLIAGE SHRUBS.

3,500 ft.

Pavetta indica.—Flowers white.
Russellia juncea.—Flowers scarlet.
Sanchezia nobilis.—Ornamental variegated leaves.
Strobilanthes coloratus.—Flowers dark purple.
Montanoa bipinnatifida (Daisy-tree).—Flowers white.
Graptophyllum hortense.—"Caricature plant." Variegated foliage.
Tecoma Stans.—Yellow flowers.
Beloperone oblongata.—Pink flowers.

4,500 ft.

Duranta Plumieri.—Pale blue flowers.
Plumbago capensis.—Pretty blue flowers.
Berberis cristata.—Yellow flowers.
Pleroma macranthum.—Large violet flowers.
Bocconia frutescens.—Large ornamental leaves.
Iresine Herbstii.—Ornamental variegated foliage.
Musa coccinea.—Flowering-banana, Scarlet flowers.
Streptosolen Jamesoni.—Showy orange-red flowers.
Brunfelsia uniflora.—Bluish-white flowers, scented.
Hedychium coronarium.—Flowers white, scented.

6,000 ft.

Duranta fastuosa.—Flowers large, white.
Habrothamnus (Cestrum) elegans.—Bears bright crimson berries.
Hydrangea.—Flowers blue, pink or white.
Libonia floribunda.—Orange-red flowers.
Fuchsia arborescens.—Showy lilac flowers.
Heliotrope.—Blue flowers.
Roses.—Different varieties.
Vinca.—(Periwinkle) Blue or white.
Spiroea peruviana.—Creamy-white flowers.

ORNAMENTAL CLIMBERS.

Coboea scandens.—Large plant; flowers purplish white.
Mandevillea suaveolens.—Chili Jasmine. Flowers large, pure white.
Solanum jasminoides.—Flowers white, showy.
Thunbergia wightiana.—Flowers yellow and brown.
Tacsonia.—Different varieties. Flowers showy.
Tropoeolum (Nasturtium).—Flowers yellow, &c.
Wistaria sinensis.—Flowers beautiful, pale-purple.

Coreopsis.
Cosmos.—Pink and white.
Dianthus.—Indian pink.
Exacum macranthum.
Larkspur.
Linaria.
Linum.
Mignonette.
Nemesia.—Six to eight inches high.
Nicotiana.—White, pink, &c.
Petunia.—Single, different shades.
Phlox Drummondii.—Different shades.
Poppies.—Different shades.
Portulaca.—"Sun Plant"; dwarf.
Salpiglossus.
Schizanthus.
Verbena.
Zinnia.

CLIMBERS.

Ipomoea Briggsii.—Dark-crimson flowers.
Bignonia venusta ("Tanga-poo")—Flowers orange-yellow.
Solanum seaforthianum.—Blue flowers

BULBOUS AND TUBEROUS PLANTS.

Agapanthus umbellatus.—Lovely blue flowers.
Cyrtanthus.—("African Bride").—White or pink, scented.
Dahlias.—Purple, yellow, scarlet, &c.
Hippeastrum.—Different varieties; large showy flowers.
Ixia pendula.—Orange-yellow.
Tritonia aurea.—Orange-yellow.
Cannas.—Yellow, scarlet, &c. Numerous varieties, very showy.

POT-BORDER-PLANTS, &c.

Cineraria.—Blue, white, scarlet, &c.
Violets.—Blue, violet, purple, white.
Daisies.—White, scarlet, &c.
Geraniums.—Scarlet, pink, white, &c.
Santolina ("Cotton Lavender").—White cottony foliage, scented.
Pansies.—Different colours.
Sweet Pea.—Various shades.

MARKET RATES.

MARKET RATES FOR SOME CEYLON PRODUCTS.

(FROM THE CEYLON CHAMBER OF COMMERCE WEEKLY PRICE CURRENT, DATED 11th MAY, 1925.)

NAME OF PRODUCE		CURRENT PRICE Rs. cts.	at	Rs. cts.	REMARKS
CACAO—(At Buyer's Stores)					
Estate—Finest	... per cwt.	47 00	,,	54 00	
Do Medium	... do	38 00	,,	48 00	
Do Common (Black)	... do	15 00	,,	30 00	
CARDAMOMS—					
All round parcel well bleached ...	... per lb.	... ...	,,	... ...	No quotations available
Do do medium	... do	... ...	,,	... ...	
Special assortment 0 & 1 only ...	... do	... ...	,,	... ...	
Seeds	... do	... ...	,,	... ...	
Green	... do	... ...	,,	... ...	
CINNAMON QUILLS—(At Buyer's Stores)					
Ordinary assortment (in bales of 100 lb. nett) ...	... per lb.	0 84	,,	0 90	
No. 1	... do	0 88	,,	0 94	
No. 2	... do	0 85	,,	0 91	
No. 3	... do	0 82	,,	0 88	
No. 4	... do	0 78	,,	0 83	
CINNAMON CHIPS—Maradana, (At Buyer's Stores) (in bags of 56 lb. nett) per candy of 560 lb.		70 00	,,	80 00	
CITRONELLA OIL—(ex-Seller's Stores without packages) ...	per lb.	1 60	,,	1 70	
COCONUT—(Desiccated) Granulated goods (Delivered at Wharf or Buyer's Stores)					
Assortment: Medium 50 per cent. Fine 50 per cent.	... per lb.	0 19¼	,,	0 20	
COCONUT OIL—					
White Oil F.o.b	... per ton	575 00	,,	577 00	
Ordinary Oil do	... do	555 00	,,	557 50	
COPRA—	No. 1 quality per candy of 560 lb.				
Calpentyn		82 00	,,	84 00	
Estate	,, ,,				
Ordinary quality (Maravila)	,, ,,				
Cart Do do	,, ,,				
FIBRES—(At Buyer's Stores)					
Coconut Bristle No. 1	... per cwt.	8 00	,,	8 50	
Do No. 2	,, do				
Coconut Mattress No. 1	... do	1 90	,,	2 50	
Do No. 2	... do				
Coir Yarn, Kogalla Nos. 4 to 9 ...	... do	10 00	,,	25 00	
Do Colombo Nos. 3 to 7 ...	... do				

PLUMBAGO		X. B. Rs. cts.		Rs. cts.	B. Rs. cts.		Rs. cts.	B. E. Rs. cts.		Rs. cts.
Ordinary Lumps ...	... per ton	350 00	at	415 00	250 00	at	350 00	200 00	at	250 00
Chips ...	... do	250 00	,,	325 00	200 00	,,	260 00	110 00	,,	225 00
Dust ...	... do	175 00	,,	225 00	125 00	,,	175 00	60 00	,,	110 00
Do Flying ...	... do	100 00	,,	145 00	75 00	,,	100 00	45 00	,,	75 00

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MAY, 1925.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1925	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	75	—	25	24	—	26
	Foot-and-mouth disease	1289	440	1229	4	55	1
	Anthrax	—	—	—	—	—	—
Colombo Municipality	Rinderpest	1	—				
	Foot-and mouth disease	275	1				
	Anthrax	—	—				
	Rabies	5	—				
Cattle Quarantine Station	Rinderpest	—	—				
	Foot-and-mouth disease	36	1				
	Anthrax	109	12				
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	257	2	257	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	9	—	—	9	—	—
	Piroplasmosis	1	1	—	1	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	256	126	256	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	14	—	14	—	—	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	443	49	443	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	155	60	95	11	49	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	444	3	441	—	3	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	990	53	909	33	48	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	144	32	24	74	—	46
	Foot-and-mouth disease	451	167	343	7	99	2
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	6	—	—	6	—	—

G. W. STURGESS,
Government Veterinary Surgeon.

Colombo, 13th June, 1925.

METEOROLOGICAL
MAY, 1925.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	82·6	0	82	8·2	SW	142	8·02	29	— 4·94
Puttalam	83·2	0	78	5·0	SW	240	1·26	8	— 2·03
Mannar	86·4	+ 0·6	74	6·6	SSW	242	0·17	5	— 1·86
Jaffna	84·6	— 0·6	77	6·7	SW	399	0·78	4	— 0·92
Trincomalee	85·8	— 0·4	69	5·6	SW	231	0·99	6	— 1·45
Batticaloa	84·2	— 0·4	78	4·4	—	154	3·12	7	+ 1·39
Hambantota	82·4	+ 0·2	82	4·8	SW	340	1·03	8	— 2·12
Galle	81·4	— 0·4	84	6·4	W	224	10·75	26	— 0·55
Ratnapura	81·6	— 0·3	82	6·9	—	—	18·79	27	+ 1·03
Anu'pura	82·9	— 0·7	78	5·8	—	—	0·70	7	— 2·56
Kurunegala	81·8	— 1·0	78	7·8	—	—	7·64	18	+ 1·40
Kandy	78·1	— 0·6	81	7·7	—	—	10·82	19	+ 4·44
Badulla	75·6	— 0·4	80	5·2	—	—	6·03	11	+ 1·54
Diyatalawa	70·8	+ 0·2	74	6·6	—	—	6·06	13	+ 1·16
Hakgala	65·1	+ 1·4	81	6·8	—	—	7·60	18	+ 0·86
N.' Eliya	62·3	+ 0·5	82	8·0	—	—	9·31	25	+ 2·70

The total rainfall for May, 1925, did not vary greatly from the average for the month. The chief differences, both above and below, occurred in the South-West quarter of the island. The average was passed at nearly all stations (except Galle) south of a line from Kalutara to Kandy (inclusive) while between this line and the west coast was the area in which deficits were most marked.

Carney had, once again, the highest total, namely 40·16 inches but the biggest offsets from average were in the Deniyaya district where Panilkanda with 25·05 had more than double its average for May.

In the north of the island small deficits were recorded at most stations and in the East and South-East there were small offsets both above and below average, the latter being slightly the more common.

The heaviest rain was in the Matara and Ambegamuwa districts on the 12th-14th, when Ceylon got some of the early effects of a storm that subsequently did a good deal of damage further north. On the 12th Hali-Ela reported 8·4 inches and Morawaka and Mawarella both had over 6 inches. On the 13th Blackwater was the highest with 6·2, but on the 14th Ellawella had 8·6, and Denagama 8·3, while on each of these days falls of over 5 inches were too numerous to mention in detail.

A. J. BAMFORD,
Supdt. Observatory.